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ABSTRACT

This thesis describes a study of the management of chemical waste at the State University of New York at Binghamton. The study revealed that the majority of chemical waste at the university is in the form of hazardous waste. It was hypothesized that the volume, related costs, and potential long-term liability associated with the disposal of hazardous waste could be reduced by using segregation, bulking, and neutralizaton methods. A revised chemical waste management program was developed. One year after implementation the volume of hazardous waste was reduced by 67 percent. Over $11,400 in related costs was saved. The potential long-term liability, on a per-drum basis, was reduced by nearly 93 percent. (Author/TW)

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THE MANAGEMENT OF CHEMICAL WASTE IN A UNIVERSITY SETTING

A Thesis

Presented in Partial Fulfillment of the Requirements
for the degree Master of Science in the
Graduate School of the Ohio State University

by

David Michael Coons, B.S.

* * * * *

The Ohio State University

1987

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SE 049 015

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THESIS ABSTRACT

THE OHIO STATE UNIVERSITY
GRADUATE SCHOOL
(Please type all information requested.
The margin requirements are the same as
those for the text of your thesis.)

NAME: David Michael Coons **QUARTER/YEAR:** AU 1987

DEPARTMENT: School of Natural Resources **DEGREE:** Master of Science

ADVISER'S NAME: Dr. John F. Disinger

TITLE OF THESIS: The Management of Chemical Waste in a University Setting

Summarize in the space below the purpose
and principal conclusions of your thesis.
(Please single space and do not exceed 100 words.)

A study was made of the management of chemical waste at The State University of New York at Binghamton. The study revealed that the majority of chemical waste is disposed of as hazardous waste. It was hypothesized that the volume, related costs, and potential long-term liability associated with the disposal of hazardous waste could be reduced by using segregation, bulking, and neutralization methods. A revised chemical waste management program was developed. One year after implementation the volume of hazardous waste was reduced by 67 percent. Over $11,400 in related costs was saved. The potential long-term liability, on a per-drum basis, was reduced by nearly 93 percent.

Adviser's Signature

This thesis is the result of many long hours away from three people very important to me--my wife, Angie, who has supported my work and understood my absence in the short-term; and my children, Matthew and Jeremy, always asking "how did you do on your thesis" and "how many pages did you get done." Thank you for believing in me. I love you very much.

ACKNOWLEDGMENTS

The work that this thesis represents is the result of my professional endeavors in the field of health and safety at The Ohio State University and at The State University of New York at Binghamton. These two great institutions have my appreciation for the opportunity to prove myself, but Ohio State will always have my heart.

A special thanks must be given to Dr. Edward J. Lazear, who allowed Richard Schultz and myself to develop the chemical waste management program for Ohio State. Dr. Lazear's support and the freedom he allowed us will never be forgotten.

One's graduate advisor should always be remembered. I've known Dr. John F. Disinger as a professor, a consultant, a moderator, a director, and a friend. I will always remember him as a friend. Thank you.

VITA

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CHAPTER I

INTRODUCTION

Background and Setting

The management of chemical waste at a university requires a complex system of policies and procedures designed to control chemical residuals generated by various academic and support activities. These activities may include classroom and research laboratories, maintenance functions, physical plant operations, print facilities, and other university-supported functions such as hospitals and industrial pilot plants. Unlike the processes of industry, where mass production generates a specific waste in large quantities, a university is made up of many diverse and unrelated groups (Furr, n.d.; Willhoit, n.d. and others). The chemicals used and the subsequent volume of waste generated by universities reflect this--quantities are relatively small and the composition of the waste can be as diverse as the groups (Findley, 1985). This diversity can complicate management efforts and reduce the effectiveness of any program.

A study was made of the policies and procedures addressing chemical waste at the State University of New York at Binghamton (SUNY-Binghamton). The objectives of the case study were: 1) to gain an understanding of the present policies and procedures addressing waste chemicals at SUNY-Binghamton; 2) to evaluate the management of that waste in terms of handling and disposal; and 3) to serve as a basis for any modifications to the program that may be implemented in an effort to reduce the volume and associated costs for disposal of waste chemicals at SUNY-Binghamton.

SUNY-Binghamton is the smallest of four University Centers in the State of New York. It maintains fifty-two buildings/complexes where offices, laboratories, classrooms, student-residence, and support facilities are located (Figure 1, page 3). During the school year, the population of SUNY-Binghamton consists of about 15,000 students, faculty, and staff. This study focused primarily on the departments that typically generate waste chemicals. These departments include chemistry, biological sciences, geology, and physical plant. However, other areas that occasionally generate waste, such as the Watson School of Engineering, were included.

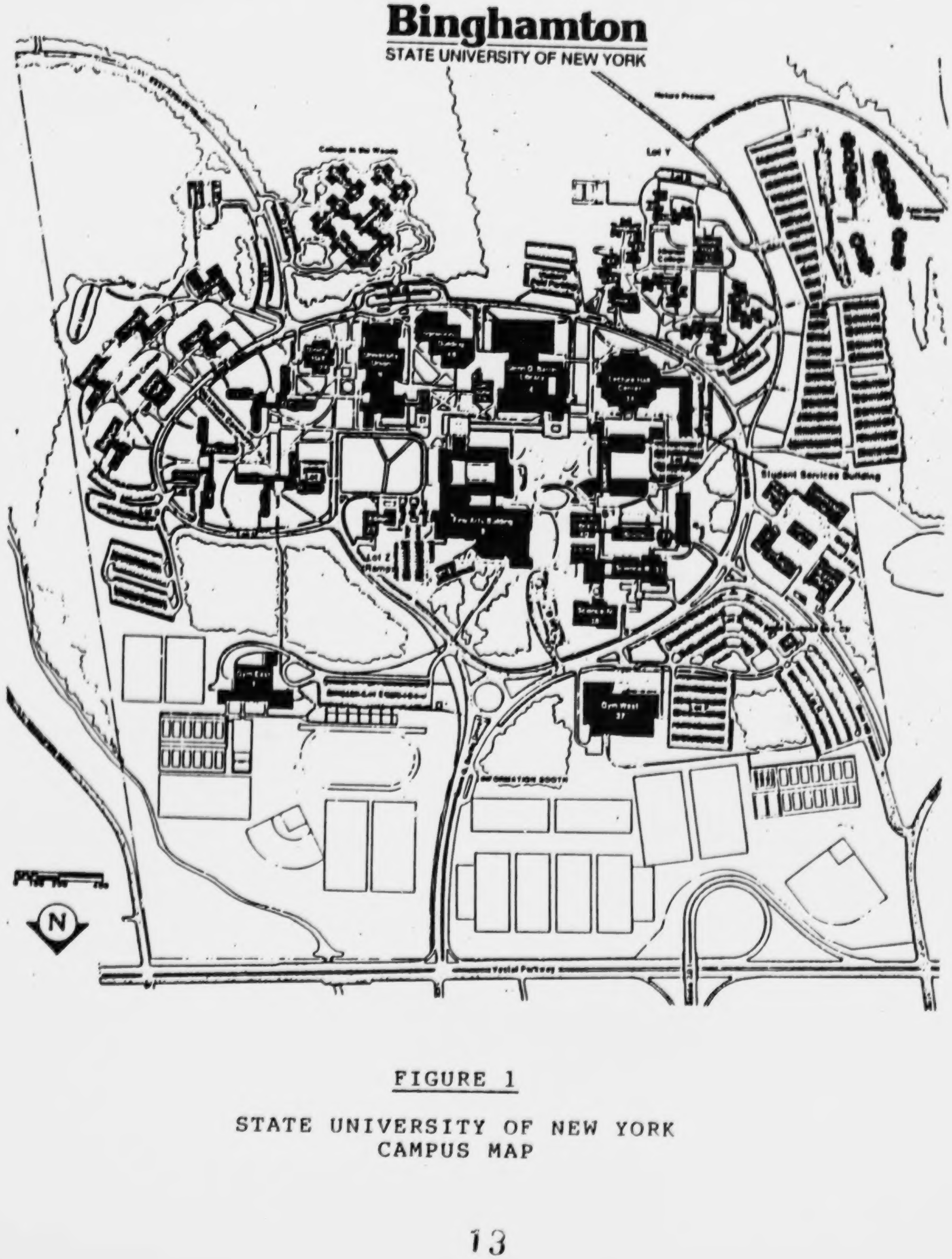

Binghamton
STATE UNIVERSITY OF NEW YORK
Nature Preserve
College in the Woods
Lot Y
Student Services Building
Fine Arts Building
Lecture Hall Center
Gym East
Gym West
37
INFORMATION BOOTH
Vestal Parkway
N

FIGURE 1

STATE UNIVERSITY OF NEW YORK
CAMPUS MAP

Historical Perspective

Various methods of waste disposal were used prior to the Resource Conservation and Recovery Act of 1976 (RCRA). The most common methods were disposal through the county landfill and the sanitary sewer system (Corderman, 1985). Prior to government regulations prohibiting indiscriminate disposal of chemicals, landfilling and pouring small amounts of chemicals down the drain were the acceptable means of disposal by generators of waste chemicals (Ashbrook, 1985; Quam, n.d. and others). Although records of generation and disposal were not kept during this period, it can be assumed that actual quantities disposed in this manner were relatively small (given the size of SUNY-Binghamton during this period).

Waste motor oil was given to various local industries to be burned for energy recovery. This is still an acceptable method of disposal and is being practiced today.

During the 1970's environmental movement, changes in attitudes produced a shift in disposal methods. In 1974, the Safety Department was established as a branch of the Security Department and took responsibility for the management of chemical waste. In 1976, the Safety Department separated from Security and later became the Department of Occupational Safety and Health (DOSH).

During this period, efforts were made to reclaim solvent waste through private chemical companies marketing that service. A limited in-house recycling program was started that offered unopened or partially used bottles of chemicals to other persons in the Chemistry Department.

Chemicals that had no immediate value and posed a hazard were disposed of by three basic methods. Unstable compounds were handled in-house, using procedures established by the Manufacturing Chemists Association (now the Chemical Manufacturers' Association). This process involved the ignition and open burning of the waste.

The second method was evaporation. Organic solvent wastes were transported to Cornell University in Ithaca, New York, where they were poured onto an evaporation pad approved by the New York State Department of Environmental Conservation (NYSDEC). The threat of air pollution resulting from the evaporation of the waste resulted in the discontinuance of this disposal method.

With the advent of RCRA, a third method was introduced--lab packing. Lab packing is a procedure whereby small containers of waste are placed in a larger metal container, usually a 55-gallon drum, and surrounded with an absorbent material for burial in a secure landfill (American Chemical Society, 1985; Sanders, 1981 and others). Lab packing is the present method of disposal at SUNY-Binghamton for most waste chemicals generated in the laboratories. It should be noted that although seldom used, deep-well injection, incineration, and heat recovery are other methods used for the disposal of waste chemicals.

Management Procedure Number 808

The Office of the Vice President for Finance and Management publishes Management Procedures to establish university policy. Management Procedure Number 808 (MP 808), the "Waste Chemical Disposal Procedure," is a six-page document detailing the steps that must be taken in order to dispose of a chemical waste at SUNY-Binghamton (Appendix A, page 107). Although updated numerous times since the original procedure was authored in 1977, the present revision has been in effect since 1983.

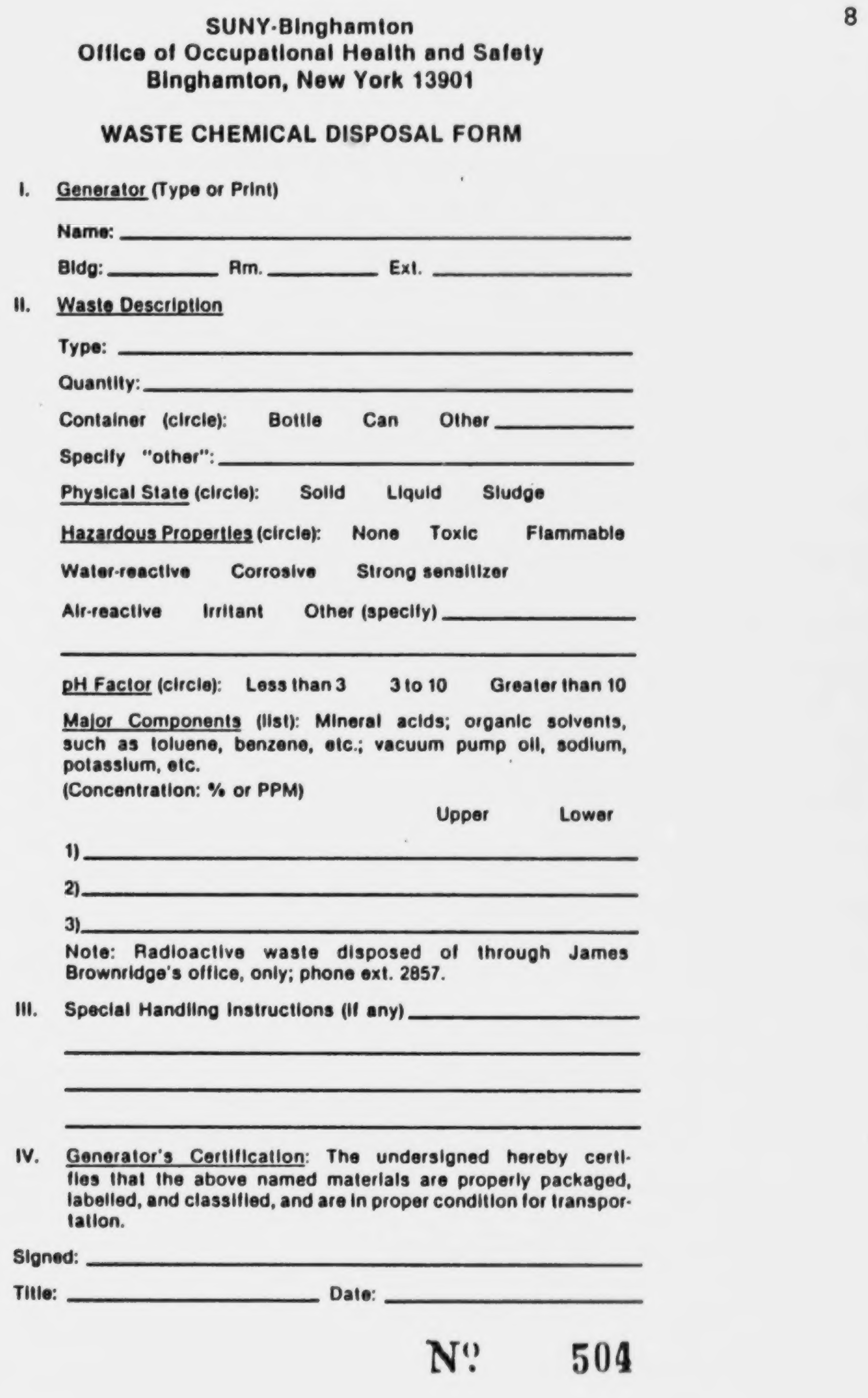
Laboratories that generate waste chemicals are responsible for providing a collection and storage container for that waste. These wastes are segregated into specific categories as follows: chlorinated solvents, non-chlorinated solvents, acids, alkalis, and solid waste chemicals.

If the contents of a container is unknown, it is the responsibility of the generator to identify the contents by the use of analytical or other methods before it is offered to DOSH for disposal. Unlabeled, mislabeled, or other "unknown" waste chemicals cannot be disposed of legally and will not be accepted into the program until they are identified.

A Chemical Waste Disposal Form (Figure 2, page 8) is completed by the faculty or staff member that generated the waste. This three-part form is used to identify the generator by name and location and to describe the waste chemical. A signature is required at the bottom of the form certifying that the information is correct and to focus liability.

The original copy is forwarded to DOSH via university mail. The yellow copy is retained by the generator. The tan copy is made of card stock and is fastened to the container with a wire loop or strong tape. This card stays attached to the container and is placed into the lab pack for disposal.

The university maintains a waste chemical storage shed located in the Science 1 building. Waste chemicals are accepted at that location on Friday mornings only. Departments are asked to arrange a



8

SUNY-Binghamton
Office of Occupational Health and Safety
Binghamton, New York 13901

WASTE CHEMICAL DISPOSAL FORM

I. Generator (Type or Print)

Name: ____________________

Bldg: ________ Rm. ________ Ext. ________

II. Waste Description

Type: ____________________

Quantity: ____________________

Container (circle): Bottle Can Other ________

Specify "other": ____________________

Physical State (circle): Solid Liquid Sludge

Hazardous Properties (circle): None Toxic Flammable
Water-reactive Corrosive Strong sensitizer
Air-reactive Irritant Other (specify) ________

____

pH Factor (circle): Less than 3 3 to 10 Greater than 10

Major Components (list): Mineral acids; organic solvents, such as toluene, benzene, etc.; vacuum pump oil, sodium, potassium, etc.
(Concentration: % or PPM)

Upper Lower

1) ____________________

2) ____________________

3) ____________________

Note: Radioactive waste disposed of through James Brownridge's office, only; phone ext. 2857.

III. Special Handling Instructions (if any) ____________________

____

____

____

IV. Generator's Certification: The undersigned hereby certifies that the above named materials are properly packaged, labelled, and classified, and are in proper condition for transportation.

Signed: ____________________

Title: ________ Date: ________

Nº 504

FIGURE 2

THREE-PART CHEMICAL WASTE DISPOSAL FORM
USED IN MANAGEMENT PROCEDURE NUMBER 808

specific time for delivery with DOSH in order to avoid delays and promote efficient handling of the waste.

Each laboratory is to designate a representative who is responsible for the handling and delivery of waste chemicals to the storage shed. This person will assist DOSH in lab packing their waste into the drum(s). A log shall be kept by the department representative of all waste placed into the lab packs. The purpose of this log is to keep a record of the contents of each drum by department.

General information on the compatibility groups of chemicals and exceptions to those groups are included in MP 808. This information is offered to give direction for segregation during handling and packaging. It is intended to reduce the risk of an adverse chemical reaction in the event of breakage of waste containers packed in the drum and to avoid costly repackaging by the disposal company at a later date.

MP 808 suggests that chemicals be purchased only in quantities that will supply what is needed in the short-term. Controlling the quantities purchased should minimize the chemical burden at SUNY-Binghamton. It is stressed that, although purchasing a larger volume of a needed chemical compound may offer short-term savings, the high costs for disposal of any unused portion will offset any perceived savings. This practice is generally supported (American Chemical Society, 1985; Bauer, n.d.; Furr, n.d. and others).

Recycling is briefly mentioned. All recoverable mercury, which is in the elemental form, is returned to a designated representative in the Chemistry Department. The elemental mercury is packaged and sent to a private salvage company where it is cleaned and returned to SUNY-Binghamton for reuse.

A small supply of "common" chemicals--unwanted chemicals acquired from various laboratories--is kept in storage by the Chemistry Department. They are intended for redistribution to any user and are available upon request.

Evaluation of MP 808

As part of the study, the management of waste chemicals was evaluated in terms of handling and disposal. The evaluation was based on observations made by this writer with respect to the policies and procedures outlined in MP 808.

No schedule for the delivery of waste chemicals was apparent. Departments or laboratories would contact DOSH--by telephone to establish a delivery time convenient to both parties, or by campus mail, where DOSH would then contact the generator to schedule same. It was not uncommon for unknown persons to enter the waste chemical storage shed without contacting DOSH and "drop off" waste chemicals at their discretion. Although the waste chemical storage shed was considered a secure area, a number of pass- keys were apparently available.

Packaging of lab packs is no longer accomplished at the time of delivery. Guidelines established by the private company that disposes of waste chemicals from SUNY-Binghamton require the packaging of lab packs be completed by company personnel. Bottles of waste with the university's disposal form attached are stored on the floor and on shelves in the storage shed until the disposal company arrives, which is typically three to four times a year.

Many of the disposal forms did not clearly define the contents of the container or the hazards associated with the waste. Although the name of the person generating the waste was usually given, the description of the waste would be in general terms, such as "organic solvent" or "acid waste." Others would indicate, as requested, upper and lower concentrations of the major components allowing the reader to determine a quantity range of a given component. However, it was not uncommon to discover containers with blank forms attached or the forms missing altogether. When generators were contacted regarding incomplete or inadequate information on the form, accurate quantities could not be given and identifying the components of the waste was based on their best recollection.

Methods recommended in MP 808 are intended to reduce the volume of waste chemicals as well as the chemical burden on campus. Unfortunately, a lack of communication between DOSH and the waste generators existed and was a deterrent to any measurement of success or failure. It could not be determined whether the recommendations in the procedure were effective.

All laboratory waste chemicals received by DOSH were eventually lab packed for disposal in a secure landfill. Turpentine, collected in two 5-gallon liquid-flammable safety containers, was picked up from the Fine Arts Department by DOSH personnel and poured into 55-gallon drums. The emptied containers were then returned to the department. Photographic developer waste and waste formalin were received in a variety of container types and poured into 55-gallon drums dedicated for that waste stream.

Except for the photographic developer waste and used motor oil, which are given to local companies for reclamation and heat recovery respectively, recycling was intradepartmental; therefore, not apparent during the study. Further investigation revealed that a small room in the science complex was used to store the "common" chemical compounds that were considered available upon request. No inventory existed and a person would have to browse through the partially alphabetized stock in search of a particular compound. Discussions with Chemistry Department personnel suggested that chemicals from this room were seldom used.

SUNY-Binghamton or DOSH have no committed budget to fund the waste chemical management program. However, the College of Arts and Sciences funds the program since the majority of the waste chemicals on campus are produced by the academic departments it administers. As the need arises, the college purchases supplies, such as drums and packaging material, and pays for the services of a private company to lab pack, transport, and dispose of all chemicals accepted by the program.

Background to the Problem Statement

Most of the waste chemicals at SUNY-Binghamton are disposed through lab packing and subsequent landfilling. A small portion of the waste is disposed of by incineration, recovery, and deep-well injection. Records indicate that some of this waste was non-hazardous and could have been disposed of by placing it in the local sanitary landfill or the sanitary sewer system. Furthermore, there were no observed efforts towards volume reduction of those wastes considered hazardous. Ashbrook (1985) and recommendations by the American Chemical Society (1985) address the need for colleges and universities to practice source separation and segregation as a viable means of waste reduction. Methods of collection, preparation, and in-house treatment support these efforts (Armour, 1984; Eaker, n.d. and others).

On August 9, 1985, a licensed disposal company prepared and transported a shipment of hazardous waste from SUNY-Binghamton. Thirty-seven drums were shipped consisting of nine 5-gallon pails, six 30-gallon drums, and twenty-one 55-gallon drums. Four of the

55-gallon drums contained 50 gallons of bulked liquid chemical waste and 33 pails and drums were packaged by company personnel using company procedures. The fate of this shipment was as follows: seventeen 55-gallon drums, five 30-gallon drums, and four 5-gallon pails were buried in a secure landfill; one 30-gallon drum and six 5-gallon pails were chemically or physically treated as a means of disposal (this could have included burning, hydrolysis, or other accepted method); the contents of three 55-gallon drums were deep-well injected, and the contents of one 55-gallon drum was recycled.

There are alternative collection and disposal methods available that are environmentally sound and offer a reduction in the volume, cost, and long-term liability associated with hazardous waste. Pipitone (1984), Eaker (n.d.), and Gibbs (n.d.) describe a collection and storage method for liquid-flammable waste that reduces the number of drums needed for disposal. Furthermore, this method collects the waste in a form that is more suitable for destruction by incineration or heat recovery at a reduced fee. Flammable solvents poured into common containers, such as 55-gallon drums, consolidate the waste, whereas lab packing allows for not more than 15 one-gallon containers to be packed into a 55-gallon drum (American Chemical Society, 1985). Comparatively, materials and costs can be reduced using alternative disposal methods.

Schultz (1985), Armour (1985), and others have been successful in disposing of corrosive acids and bases using in-house neutralization procedures. Adjusting the pH of most acids and bases to an acceptable level will result in a non-hazardous solution that can be flushed into the sanitary sewer system.

The information from the packing list for each drum in the August 9, 1985 shipment was used to estimate the volume of waste generated if similar reduction techniques described above had been used. The waste chemicals were segregated into specific classes--flammable liquids, corrosives, poisons, reactives, and non-hazardous materials--and quantities were noted. Pouring flammable liquids into common drums would have produced about nine 55-gallon drums (including the four that had already been bulked). Neutralization of corrosive acids and bases would have eliminated one 55-gallon drum, two 30-gallon drums, and two 5-gallon pails.

The estimated total shipment would have consisted of the following: nine 55-gallon drums containing 50 gallons of bulked flammable liquids; two 30-gallon drums of lab packed bottles of poisons and reactives; and six 5-gallon pails of reactive compounds. Given the alternative methods of collection and in-house neutralization techniques available, a substantial reduction in the number of containers was possible. Furthermore, these alternative methods would have reduced the material, labor, and shipping and handling costs associated with disposal.

The majority of the August 9th shipment was buried in a secure landfill. This method of disposal, however, does not eliminate the hazardousness of a waste. Hileman (1983) reports that about 80 percent of all hazardous wastes are disposed in or on the land and no matter how well a landfill is designed, it will eventually leak. Although considered an ultimate disposal method, burying waste, even in today's state-of-the-art secure landfills, is a long-term means of storage that requires constant safeguards against environmental contamination.

The generator of buried wastes can be held liable for a portion of any future clean-up costs under the

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, also referred to as CERCLA, or Superfund (Arbuckle, 1983; Ashbrook, 1985 and others). If the available methods that destroy hazardous wastes were used, e.g., incineration, heat recovery, and hydrolysis, the potential long-term liability associated with the burying of the above wastes would have been eliminated.

The Hazardous and Solid Waste Amendments of 1984, or HSWA, strengthened RCRA by requiring all generators of hazardous waste to certify the following: 1) that they have a program in place to reduce the volume or quantity and toxicity of such waste to the degree determined by the generator to be economically practicable and 2) that the proposed method of treatment, storage, or disposal is that practicable method currently available to the generator which minimizes the present and future threat to human health and the environment (42 U.S. Code, Sect. 224(b), 1984). The U.S. Congress has determined that the reliance on land disposal should be the least favored method of disposal for hazardous wastes and that it should be minimized or eliminated (Congressional Record, 1984). Therefore, the U.S.

Environmental Protection Agency (USEPA) is mandated by HSWA to develop regulations banning specific wastes from landfills and/or demonstrate which of those wastes, if any, can be safely disposed in that manner. The Bureau of National Affairs, or BNA (1986), outlines the USEPA's schedule for carrying out the mandates set forth by HSWA. Effective November 8, 1986, specific spent halogenated and non-halogenated solvent wastes, identified by USEPA hazardous waste numbers F001 through F005, were prohibited from land disposal. Effective July 8, 1987, the prohibitions were expanded to include what is commonly referred to as the "California list." This list includes specific halogenated organic compounds in specified concentrations and all liquid hazardous wastes that have a pH of less than or equal to 2.0.

Problem Statement

At the present time, SUNY-Binghamton has no policy or procedure that reduces the hazardous waste generated on campus. Segregation of the non-hazardous waste from the hazardous waste is not practiced nor are any efforts made to reduce the volume or toxicity of that waste. The waste chemicals generated on campus and accepted by DOSH are classified into specific categories, as defined by MP 808, with the majority lab packed and eventually disposed by burial in a secure landfill. This method is costly and establishes a long-term liability for the waste. Therefore, the present management procedure must be revised to reflect compliance with present regulations and to prepare for the additional disposal restrictions that will become effective in the near future.

Definitions

Environmental legislation has introduced and fostered a variety of terms related to chemicals and chemical products that may adversely affect human health and the environment. Although some of these terms are similar in definition, the context in which they were written differ and they should not be used synonymously.

Definitions that explain terms used in this study are as follows:

A "chemical waste" is generally described as any unwanted residual or unusable by-product from an industrial, manufacturing, service operation, or laboratory where chemical substances are used.

A "toxic pollutant" is a material including disease-causing agents, which after being discharged in water and upon exposure, ingestion, inhalation, or assimilation by an organism will cause death, disease, or other adverse health effect in that organism or its offspring. These effects may be caused directly from the environment or indirectly through the food chain (33 U.S. Code, Section 502(13), 1983).

A "toxic substance" is a chemical or mixture that may present an unreasonable risk of injury to human health or the environment (Frick, 1984).

A "hazardous material" is a substance or material which has been determined to have the potential of posing an unreasonable risk to health, safety, and/or property when transported in commerce (49 U.S. Code, Section 103(2), 1972).

A "hazardous substance" is the following: 1) a toxic pollutant pursuant to the Federal Water Pollution Control Act (FWPCA); 2) any element, compound, mixture, solution, or substance designated by CERCLA; 3) any hazardous waste as defined by RCRA; 4) any hazardous air pollutant as defined by the Clean Air Act; and 5) any imminently hazardous chemical substance or mixture pursuant to the Toxic Substances Control Act (TSCA). This definition does not include the following: petroleum, crude oil, or other fraction of that material that is not listed in CERCLA; natural gas; natural gas liquids; liquefied natural gas; or synthetic gas used for fuel (42 U.S. Code, Sect. 101(14), 1980).

A "solid waste" is the following: 1) any garbage, refuse, or sludge generated by a water treatment or air pollution control facility; other discarded material including solid, liquid, semisolid, or contained gaseous material generated by industrial, commercial, mining, and agricultural operations; and from community activities. It does not include the following: solid or dissolved material in domestic sewage; irrigation return flows or industrial discharges which are identified as point sources pursuant to FWPCA; or material as defined by the Nuclear Regulatory Act (42 U.S. Code, Sect. 1004(27), 1984).

A "hazardous waste," as defined by RCRA, is a solid waste that may present potential and present hazards to human health or the environment if improperly managed (42 U.S. Code, Sect. 1004(5), 1984). The USEPA expanded this definition to mean a solid waste that is not excluded from regulation and meets one of the following criteria: 1) exhibits one or more characteristics of a hazardous waste--ignitability, corrosivity, toxicity, and reactivity; 2) is specifically listed by the USEPA as a hazardous waste; 3) is solid waste mixed with a listed hazardous waste; or 4) is recycled using methods constituting disposal, burned for energy or heat recovery, or used to produce a fuel (BNA, 1986). The NYSDEC (New York State, 1985) further defines a hazardous waste to include the following: 1) specific mixtures of solid and hazardous wastes; 2) specific solvent-containing wastes; 3) specific discarded commercial chemical products, and 4) wastewater resulting from laboratory operations containing any toxic chemical wastes as listed in the NYSDEC Regulations.

"Disposal" is defined by The NYSDEC (New York State, 1985) as the abandonment, discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid or hazardous waste into or onto any lands or waters so that it may enter the biosphere, including groundwater. The NYSDEC and USEPA definitions differ slightly in that New York State accepts incineration and burning for energy recovery as a method of disposal.

"Energy recovery" is the beneficial use or reuse or legally acceptable recycling or reclamation of solid or hazardous waste through combustion to recover energy (New York State, 1985). This term is used synonymously with heat recovery.

A "generator" is any person in the area where a facility or activity is physically located or conducted, whose act or process produces a hazardous waste as defined above (New York State, 1985). In this study, the "person" is the author of this thesis and the "facility" is SUNY-Binghamton.

"Incineration" is a controlled process of burning solid and/or hazardous wastes to convert those wastes into noncombusible matter (Frick, 1984). The primary purpose of an incinerator that has been approved by the USEPA to treat hazardous waste.

"Deep-well injection" is a means of disposal where raw or treated, filtered hazardous waste is pumped into deep wells where it is contained in permeable subsurface rock formations (Frick, 1984). In addition to the underground injection of wastes, all construction, operating, and monitoring requirements are regulated by the USEPA pursuant to the Safe Drinking Water Act (42 U.S. Code, Sect. 1425, 1980).

"Lab packing" is a method of packaging containers of laboratory waste in an over-pack drum and has been approved by the U.S. Department of Transportation, or USDOT (American Chemical Society, 1986). An inert packaging material such as vermiculite or corn cob is used to pack around each container in the drum. This separates and protects the containers from damage during handling and transport of the over-pack drum. A sufficient amount of packaging material must be used to absorb any liquid released in the event of leakage or breakage. Although lab packing is intended to provide safety during transportation, this method of containerizing wastes enables lab packs to be incinerated or more commonly placed in a secure landfill, depending on the outer package and packaging material.

"Bulking" refers to a method of collection where common solvents and other liquid chemical waste are poured into a common drum. Examples of bulked chemical waste include formalin, oils, and halogenated and non-halogenated solvents.

Limitations of the Study

New York State received interim authorization from the USEPA on December 27, 1985 to conduct a hazardous waste regulatory program. An executive summary issued by the NYSDEC addresses the advantages of regulating hazardous waste at the state level and discusses statutory responsibilities associated with such an authorization (New York State, 1985). The advantages of regulating the program at the state level include the following: 1) an enhancement of statewide capabilities for the management, monitoring, and enforcement of the program and 2) a program that is more attuned to local conditions, concerns, and needs than a federal-level program. State programs must be as stringent as, but may be more stringent than, the federal program. Final authorization was received sometime in 1986.

Since HSWA requires authorized states to amend their regulations to be consistent with federal regulations within a specified deadline, and since SUNY-Binghamton must comply with the laws and regulations of New York State, this study will only make reference to hazardous waste regulations established by the NYSDEC. Table 1 (page 27) lists the equivalent New York State and federal regulations.

The purpose of these regulations is to establish standards for generators of hazardous waste and for

TABLE 1

EQUIVALENT NEW YORK STATE AND FEDERAL REGULATIONS

NYSDEC REGULATION	USEPA REGULATION	SUBJECT
PART 370	PART 260	HAZARDOUS WASTE MANAGEMENT SYSTEM: GENERAL
PART 371	PART 261	IDENTIFICATION AND LISTING OF HAZARDOUS WASTES
PART 372	PART 262 AND 263	HAZARDOUS WASTE MANIFEST SYSTEM AND RELATED STANDARDS
PART 373-1	PART 270	HAZARDOUS WASTE TREATMENT, STORAGE AND DISPOSAL (TSDF) PERMITTING REQUIREMENTS
PART 373-2	PART 264	FINAL STATUS STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TSDF'S
PART 373-3	PART 265	INTERIM STATUS STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TSDF'S
PART 621	PART 270 AND 124	UNIFORM PROCEDURES
PART 624	PART 270 AND 124	PERMIT HEARING PROCEDURES

hazardous waste treatment, storage, and disposal facilities (TSDF). SUNY-Binghamton is classified as a small quantity generator producing between 100 and 1000 kilograms of hazardous waste per month. It is not a TSDF; therefore, only regulations that relate to generators will be addressed.

Most chemical waste generated at SUNY-Binghamton is the result of work performed in the academic and research laboratories; however, other departments such as fine arts and physical plant contribute to this waste stream. There are two exceptions that meet the definition of a hazardous waste, but they are not considered in this study.

The first is Polychlorinated biphenyl (PCB) waste. Used for its exceptional heat transfer capabilities, PCBs are found in many electrical capacitors and transformers. The Department of Physical Plant has established a multi-year plan that will eliminate PCBs from SUNY-Binghamton. The disposal of PCB waste is managed by the Department of Physical Plant.

The second is exempt radioactive waste. Liquid scintillation counting is a method whereby radioactivity is detected and measured by converting scintillations, or the flashes of light produced by a ray or particle upon striking a crystal detector, into electrical signals. This counting method has become a commonly used technique for detecting radioactivity in biological samples (Federal Register, 1981; Guralnik et al., 1962). A sample is placed in a vial containing tracer levels of carbon^{14} (C^{14}) or hydrogen^{3} (H^{3}, or tritium) with a cocktail that is primarily toluene. After the counting has been completed, the vial is collected for disposal. If the radioactivity is below 0.05 microcuries per milliliter, the waste may be disposed of without regard to its radioactivity. Toluene, however, is a listed hazardous waste and must be disposed of accordingly. This waste is managed by the Department of Physics under the auspices of the University's Radiation Safety Officer.

Hypothesis

Based on information obtained during the study, it was hypothesized that the volume, related costs, and potential long-term liability associated with the disposal of hazardous waste could be effectively reduced at the State University of New York at Binghamton by:

1. identifying and segregating non-hazardous waste from chemical waste that would be considered a hazardous waste if discarded,

2. bulking solvent waste in 55-gallon drums, and

3. rendering corrosive acids and bases non-hazardous by using elementary neutralization methods as the final step in laboratory processes using these chemicals.

CHAPTER II

LITERATURE REVIEW

Related Laws and Regulations

The control of environmental pollution in the United States was seriously initiated in the 1950's with the enactment of air, water, and solid waste pollution control legislation (Dietrich, 1980). With the enactment of the Solid Waste Disposal Act of 1965 and the Resource Recovery Act of 1970, Congress began to deal with the specific problems associated with the management of solid waste disposal (Watson, 1980). Unlike other federal pollution laws that contained standards and timetables for compliance, guidelines set forth by the 1965 and 1970 Acts were mandatory for federal installations and were envisioned as "trend-setters" (Arbuckle, 1983). It was not until the passage of RCRA in 1976 that there was a comprehensive nationwide management plan designed to control hazardous waste using a "cradle-to-grave" system (Costle, 1980). Specifically, Subtitle C of RCRA mandated the USEPA, in conjunction with state agencies, to develop federal standards that include the following: the identification and definition of hazardous waste; a management plan for generators of hazardous waste; the design, performance, and operating procedures for facilities that treat, store, or dispose of hazardous waste, and guidelines that describe the conditions under which individual state governments may control their hazardous waste management programs independently of the USEPA.

The NYSDEC is authorized by the USEPA to administer New York State's hazardous waste management program. Regulations under Title 6 of the New York Code of Rules and Regulations (NYCRR) were promulgated and became effective July 14, 1985. Norman H. Nosencheck, Director of the Division of Solid and Hazardous Waste, NYSDEC, described the major differences between the New York State and federal hazardous waste regulations in an open letter to New York residents (Nosencheck, 1985). Table 2 (page 33) lists those major differences relevant to a generator of hazardous waste in New York State.

The campus of SUNY-Binghamton is physically located in the Town of Vestal, one mile west of Binghamton, New York. Chapter 44, Article XI-22 of

TABLE 2

DESCRIPTION OF MAJOR DIFFERENCES BETWEEN NEW YORK STATE AND FEDERAL HAZARDOUS WASTE REGULATIONS RELEVANT TO GENERATORS

PART 370

1. STATE REGULATIONS CONTAIN MANY DEFINITIONS NOT FOUND IN THE FEDERAL REGULATIONS.

2. THE DEFINITION OF "DISPOSAL" INCLUDES THERMAL DESTRUCTION AND THE BURNING OF HAZARDOUS WASTES AS FUEL.

PART 371

3. STATE REGULATIONS DEFINE BY-PRODUCT MATERIALS DESTINED FOR ENERGY RECOVERY AS A SOLID WASTE BY CHANGING THE FEDERAL DEFINITION OF "DISCARDED."

4. THE STATE REGULATES PCB WASTE AS A HAZARDOUS WASTE. NOTE: THE USEPA REGULATES PCB WASTE PURSUANT TO TSCA.

PART 372

5. THE STATE REGULATES WASTE FROM GENERATORS THAT GENERATE OR STORE BETWEEN 100 AND 1000 KILOGRAMS OF NON-ACUTE HAZARDOUS WASTE IN A CALENDAR MONTH.

6. GENERATORS OF HAZARDOUS WASTE IN NEW YORK ARE REQUIRED TO SUBMIT ANNUAL REPORTS WHERE THE FEDERAL PROGRAM REQUIRES BIENNIAL REPORTS.

7. THE STATE REQUIRES ACTION AND NOTIFICATION OF MANIFEST EXCEPTIONS AND DISCREPANCIES WITHIN 15-20 DAYS. THE FEDERAL PROGRAM IS 25-35 DAYS.

8. THE STATE'S ANNUAL REPORT MUST INCLUDE INFORMATION ON CHARACTERISTIC HAZARDOUS WASTE DESTINED FOR BENEFICIAL USE, REUSE, LEGITIMATE RECYCLING, OR RECLAMATION.

9. THE STATE REQUIRES GENERATORS OF HAZARDOUS WASTE TO DISTRIBUTE MANIFEST FORMS WITHIN FIVE DAYS.

10. THE USE OF A HAZARDOUS WASTE MANIFEST IN NEW YORK STATE CONSTITUTES A DETERMINATION MADE BY THE GENERATOR THAT THE SOLID WASTE IS A HAZARDOUS WASTE.

the Town of Vestal Code (1983) establishes aquifer districts and regulates zoning in those areas where the water supply is or may reasonably be located in the future. The purpose and intent of this code is to regulate land use that may contaminate current and future water supply. A special permit must be obtained from the Town Board when a business, industrial, or municipal operation in the aquifer district uses, distributes, or stores toxic or hazardous chemicals when the storage or use exceed fifty-five gallons or five hundred pounds per month, whichever is greater. SUNY-Binghamton is not a business nor is it considered an industrial or municipal operation. Furthermore, SUNY-Binghamton is a state institution and is not obligated to comply with local regulation (Corderman, 1985); therefore, the Town of Vestal Codes do not apply to activities at SUNY-Binghamton.

Wastewater from SUNY-Binghamton enters the sanitary sewerage and is transported to the Binghamton-Johnson City Joint Sewage Treatment Plant. This publicly-owned treatment works (POTW) is regulated by NYSDEC and holds a state pollution discharge elimination system (SPDES) permit to discharge treated effluent into the Susquehanna River. The Binghamton-Johnson City Joint Sewage Board (1984), pursuant to local law promulgated by the City of Binghamton (1979), established rules and regulations relating to the use of the POTW and associated sewerage. Article 5 addresses the restrictions and limitations on the use of the public sewers. Prohibited discharges include the following: 1) gasoline, kerosene, naphtha, fuel oil, benzene, or any other substances that constitute a fire or explosion hazard to the system; 2) any wastewater having a pH less than 6.0 or higher than 10.0; 3) any wastewater containing toxic pollutant in sufficient quantity to injure or interfere with the wastewater treatment process, constitute a health hazard, or adversely affect the receiving waters; 4) any noxious or malodorous materials that may create a public nuisance, health hazard, or prevent entry into the sewers for maintenance or repair; and 5) any wastewater which causes a hazard to human life or creates a public nuisance. Specified metallic substances, measured as total metal, are restricted to concentration limits based on a daily average. These substances are: cadmium (0.30 milligrams per liter, or mg/L); chromium (all valences, 12.0 mg/L); copper (8.0 mg/L); lead (2.5 mg/L); nickel (7.0 mg/L), and zinc (20.0 mg/L).

Chemical Waste Management: General

Many books, journals, magazines, and articles have been and continue to be printed and published that address the management of chemical and hazardous wastes. Literature predating USEPA's regulations and definition of a hazardous waste discusses disposal methods that would be considered unacceptable if today's standards were used. It should be noted that waste chemicals or chemical products were referred to using a number of terms. For example, the terms laboratory waste, toxic waste, discarded chemicals, chemical waste, hazardous waste, and a variety of others may or may not meet the present definition of a hazardous waste.

Steere (1971) defines burial as "a common method of disposal and one which may accomplish gradual dispersion of waste, or postponement of the problem." With respect to flammable chemicals, Steere suggested that small quantities be burned on the ground or in shallow metal containers. Larger quantities could be burned in incinerators or, if burned in a manner similar to small quantities, should be carried out in a remote area "preferably with a steady wind at one's back."

The Guide for Safety in the Chemical Laboratory (Manufacturing Chemists Association, or MCA, 1972) is a comprehensive text that addresses the disposal of chemical waste in considerable detail. Basic methods of disposal are discussed. These methods include open and incinerator burning, flushing water-soluble materials down sewers, and burying wastes. The MCA expresses concern for environmental protection and adhering to relative laws and regulations. The MCA's Laboratory Waste Disposal Manual is included in this reference and gives information and recommended disposal procedures for more than 1,100 chemical compounds.

Texts addressing hazardous waste management began to appear after the USEPA released the final rule on the federal hazardous waste management system on May 19, 1980. Metry (1980), Watson (1980), and others offered overviews of the current regulations and discussed approved or acceptable methods of compliance. Unfortunately, the regulations were amended numerous times thereafter, and these references became quickly outdated.

A more recent publication, Prudent Practices for Disposal of Chemicals from Laboratories (1983), is a report prepared by the National Research Council's Committee on Hazardous Substances in the Laboratory. The purpose of this report is to serve as a comprehensive guide to recommended practice and current federal regulations related to chemical waste management in the laboratory. The report recommends that in addition to an overall waste management policy, a laboratory policy should be implemented through written procedures and assigned responsibilities. The report stated the following: "It is essential that laboratory management at all levels, or faculty in an academic institution, be openly and actively committed to support of sound waste management policies and practices." Figure 3 (page 39) is a flowchart that lays out a waste management system suggested by the committee.

"Chemical Substances Control" (BNA, 1980 to present) is a bi-weekly bulletin and binder series that offers current facts on industry practices, regulatory impact, and control techniques. This bulletin began circulation about the time RCRA went into effect and has kept the author of this thesis up-

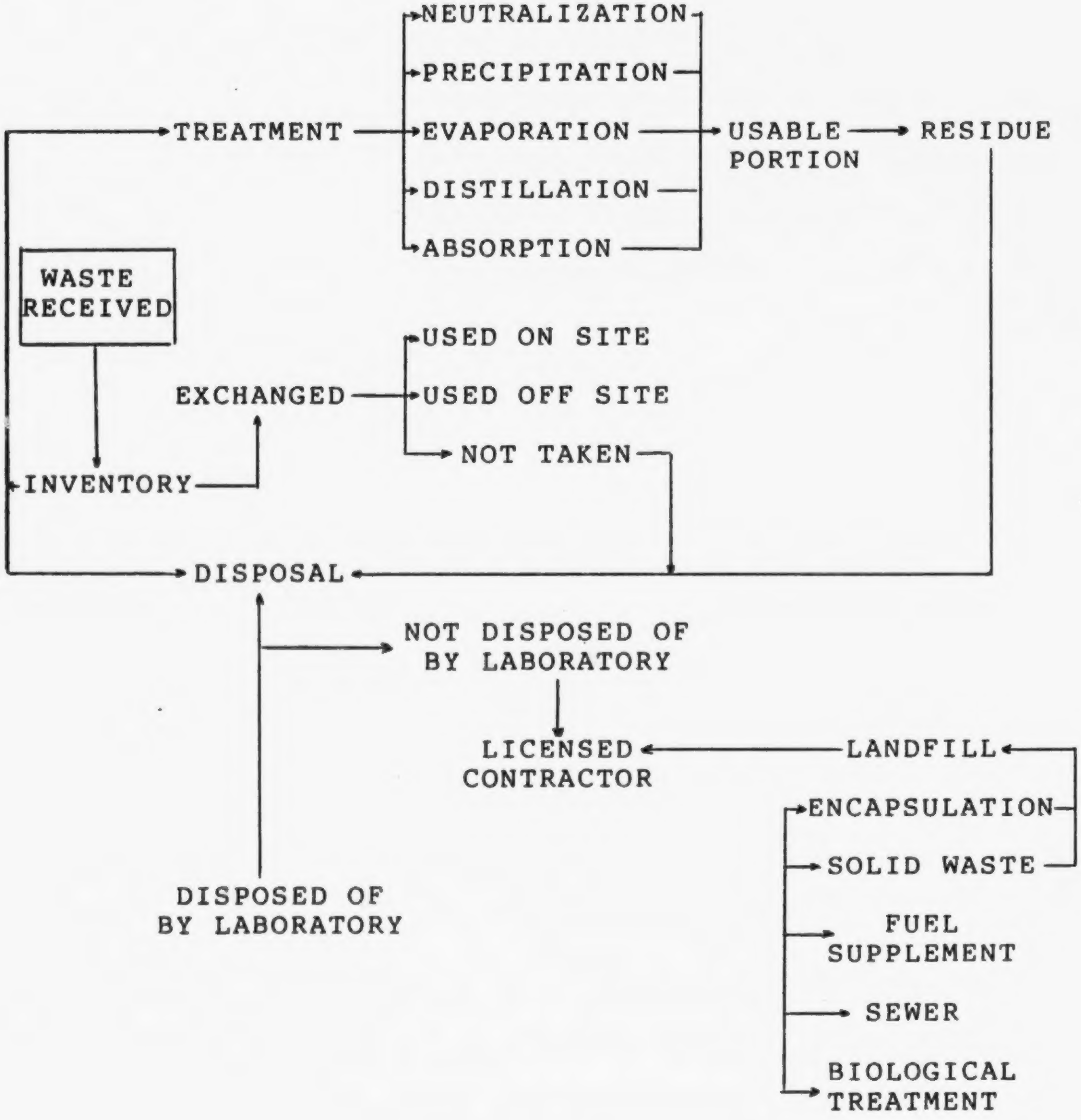

NEUTRALIZATION
PRECIPITATION
TREATMENT
EVAPORATION
USABLE PORTION
RESIDUE
DISTILLATION
ABSORPTION
WASTE RECEIVED
USED ON SITE
EXCHANGED
USED OFF SITE
NOT TAKEN
INVENTORY
DISPOSAL
NOT DISPOSED OF BY LABORATORY
LICENSED CONTRACTOR
LANDFILL
ENCAPSULATION
SOLID WASTE
FUEL SUPPLEMENT
SEWER
BIOLOGICAL TREATMENT
DISPOSED OF BY LABORATORY

FIGURE 3

SUGGESTED WASTE MANAGEMENT SYSTEM
(NATIONAL RESEARCH COUNCIL, 1983)

to-date with accurate, objective reports relating to the management of hazardous waste. Although geared towards industry and the federal program, articles relating to government programs at the state level and applicable technological innovations are not uncommon.

Two magazines that address hazardous waste management deserve mention. Hazardous Materials and Waste Management and Pollution Engineering offer current information and articles on a variety of subjects relating to chemical and hazardous waste. The former focuses on legal and management issues while the latter focuses on the engineering aspects of control and disposal.

Waste Management at Colleges and Universities

A safety monograph series is published by the National Safety Council and contains papers presented at the Annual National Conference on Campus Safety. The series reflects the changing times with respect to the management of waste chemicals in academia. Indiscriminate disposal of waste by means of evaporation, dilution, placing it in landfills, and pouring it down the drain was common prior to 1980 (Bauer, n.d.; Eaker, n.d.; Rachuk, n.d. and others). As early as 1970 Quam (n.d.) admitted that academia had dumped wastes without preliminary treatment into the sinks, allowed the deposit of wastes--regardless of the hazard--into landfills, and continued to "over-order" hazardous chemicals "far too long." Presentations at the 1979 conference reflected the guidelines and regulations pursuant to RCRA. Sudmann (n.d.) addressed the collection, storage, transportation, and disposal of hazardous wastes at the University of Oregon.

At the 1982 conference, Furr (n.d.), representing the Virginia Polytechnic Institute and State University, presented a paper entitled "A Responsible University Hazardous Waste Program." This program included the following: a centralized management; an educational program; an interactive program with the purchasing department; an interactive waste inventory using computer resources; a redistribution and recovery service; analytical capabilities; an internal transportation plan; safe internal interim storage capabilities; an adequate financing mechanism; emergency response capabilities; support of the faculty, and support of the central administration.

Dreesen (1980) reported that few colleges and universities had specific laboratory waste disposal programs and assumed that most of the hazardous waste was washed down the drain, discarded with other solid waste, or buried in some remote location. A program designed to abate this indiscriminate disposal at The University of Georgia was described. The Public Safety Division was given responsibility for the pick-up, transportation, and packaging of the waste. Lab packing, as described above, and subsequent burial in an approved landfill is the primary method of disposal. Bulking of oils, solvents, and "other liquid chemical wastes" into 55-gallon drums is briefly mentioned. This waste, however, is buried with the lab packs.

Meister (1980) discussed a waste exchange program located at the Southern Illinois University at Carbondale where contaminated solvents such as xylene or toluene can be redistilled and returned for use by the teaching laboratories. Other "repurification" techniques used are filtration, evaporation, and precipitation. Many of the other waste chemicals received are used for the neutralization of corrosive wastes. For example, acids can be mixed with bases to form harmless by-products. The advantages of this program are as follows: 1) it removes chemicals from the hazardous waste stream; 2) it reduces the need for disposal of chemical wastes; 3) it promotes recycling; and 4) it eliminates disposal costs (at this university).

The University of Minnesota (1981) produced a guidebook for laboratory personnel that addresses the management of hazardous chemical waste. Chemical wastes are first evaluated and if possible, procedures to reduce the waste are performed. The remaining waste is packed and labeled in accordance with university policy. All of the above is accomplished by the laboratory personnel generating the waste. Specially trained personnel from the Department of Physical Plant remove and transport the waste for lab packing and subsequent burial at a licensed disposal site. Flammable solvents of relative purity are used as a fuel by a private firm. An overview of this hazardous chemical waste management system is illustrated in Figure 4 (page 44).

Waste Management in Universities and Colleges (n.d.) contains the proceedings of a 1980 workshop sponsored by the USEPA. Authors from a number of universities offered their institutions' methods for handling the problems of waste management including

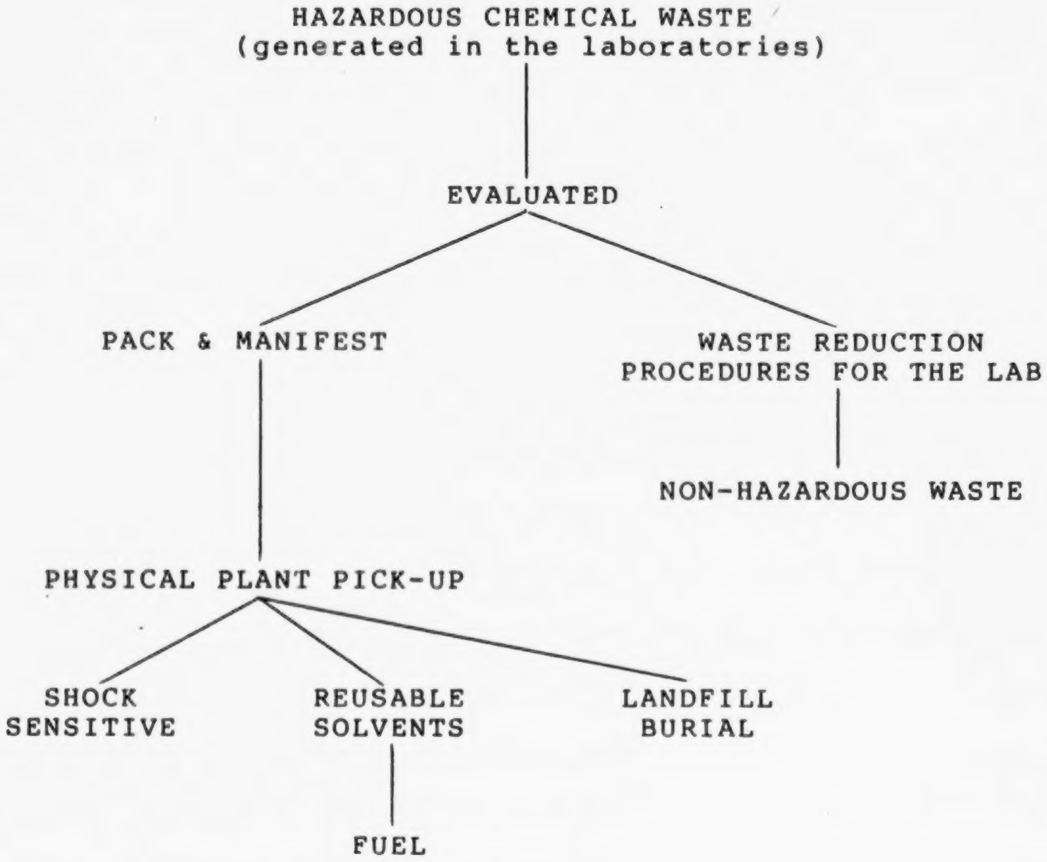

HAZARDOUS CHEMICAL WASTE
(generated in the laboratories)
EVALUATED
PACK & MANIFEST
WASTE REDUCTION
PROCEDURES FOR THE LAB
NON-HAZARDOUS WASTE
PHYSICAL PLANT PICK-UP
SHOCK
SENSITIVE
REUSABLE
SOLVENTS
LANDFILL
BURIAL
FUEL

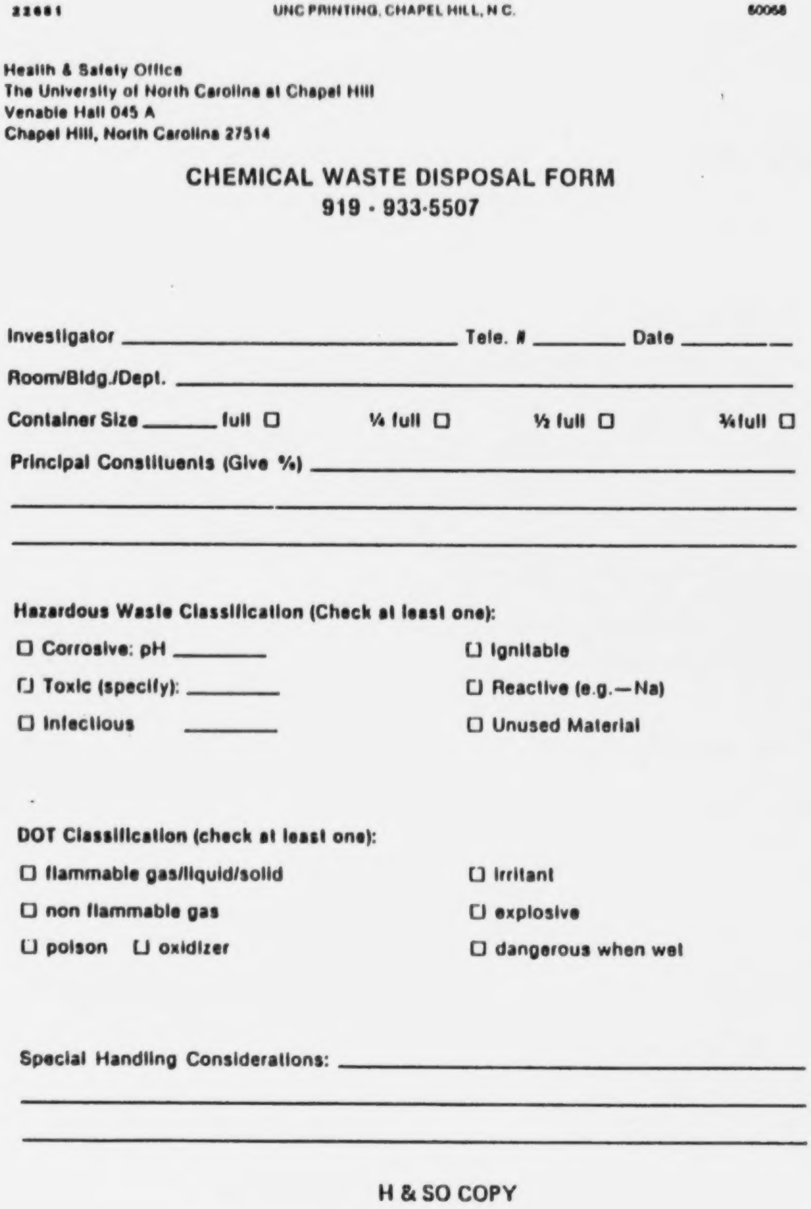
FIGURE 4

OVERVIEW OF THE HAZARDOUS
CHEMICAL WASTE MANAGEMENT SYSTEM
AT THE UNIVERSITY OF MINNESOTA

chemical and hazardous waste. Historical perspectives and newly implemented programs offered by Meister (n.d.), Koertge (n.d.) and others indicate that colleges and universities are moving from indiscriminately placing hazardous chemicals in sewers and local landfills to segregating and disposing that waste according to USEPA regulations.

Willhoit (1981) describes a chemical waste disposal program located at the University of North Carolina that is similar to the program at SUNY-Binghamton. The principal investigator in a laboratory has the responsibility of segregating wastes, filling out a chemical waste disposal form (Figure 5, page 46) and attaching one to each container, and scheduling a waste pick-up. After the pick-up, the wastes are segregated into compatibility groups based on the USDOT regulations. Wastes are either packed or poured into drums and shipped to a secure landfill. Unlike the procedures at SUNY-Binghamton, non-hazardous wastes are removed from the waste stream and disposed via the sewer or local sanitary landfill.

The Ohio State University consolidated its chemical waste disposal efforts in 1980 with the



22681 UNC PRINTING, CHAPEL HILL, N C. 60068

Health & Safety Office
The University of North Carolina at Chapel Hill
Venable Hall 045 A
Chapel Hill, North Carolina 27514

CHEMICAL WASTE DISPOSAL FORM
919 - 933-5507

Investigator ______________________ Tele. # ________ Date ________

Room/Bldg./Dept. ______________________________________

Container Size ______ full ☐ ¼ full ☐ ½ full ☐ ¾ full ☐

Principal Constituents (Give %) ______________________________

____

____

Hazardous Waste Classification (Check at least one):

☐ Corrosive: pH ________ ☐ Ignitable

☐ Toxic (specify): ________ ☐ Reactive (e.g.—Na)

☐ Infectious ________ ☐ Unused Material

DOT Classification (check at least one):

☐ flammable gas/liquid/solid ☐ irritant

☐ non flammable gas ☐ explosive

☐ poison ☐ oxidizer ☐ dangerous when wet

Special Handling Considerations: ______________________________

____

____

H & SO COPY

FIGURE 5

CHEMICAL WASTE DISPOSAL FORM
FOR THE UNIVERSITY OF NORTH CAROLINA

creation of the Division of Environmental Health and Safety. By 1981, a comprehensive standard operating procedure had been implemented that addressed the pick-up, transport, and packaging of chemical waste on campus (Coons, 1981). Although lab packing for burial was practiced, bulking of solvents for incineration, recycling, and in-house disposal methods significantly reduced the volume of waste shipped off campus. Ethanol distillation and the recycling of paint thinner, oil, and laboratory chemicals have resulted in significant savings (Schultz, 1984). By July of 1984, the savings from recycling was estimated at over $21,170 per annum.

The labor required to carry out chemical waste management programs was addressed in numerous references. Most programs had limited professional staff consisting of one or two full-time employees. This staffing was not sufficient to handle the chemical waste burden many colleges and universities were experiencing. Some institutions augmented their staff by hiring qualified students on a part-time basis or by offering academic courses or research opportunities in waste management.

Findley (1985) has prepared an excellent manual to assist colleges and universities in achieving compliance with hazardous waste regulations. Although geared to the institution having an inadequate or nonexistent hazardous waste management program, this manual uses a process of investigation and evaluation intended to determine compliance with the new federal regulations pursuant to HSWA. The manual is written so that each step in the compliance process can be used independently of the other steps if desired. A flowchart depicting this compliance evaluation scheme is presented on Figure 6 (page 49).

Chemical Waste Disposal Methods

A variety of disposal methods are available to the chemical waste generator. The Comptroller General of the United States (1980) reported that the disposal of hazardous waste on the land is the predominant method used even though it presents the greatest potential risk for surface and ground water contamination and for liability for damages. Incineration is considered as a possible solution to this nation's hazardous waste disposal problem. The report encourages the use of deep-well injection as a method of disposal. Although controversial, "Little evidence exists of any environmental problem resulting from [the] deep-well disposal [of wastes injected into

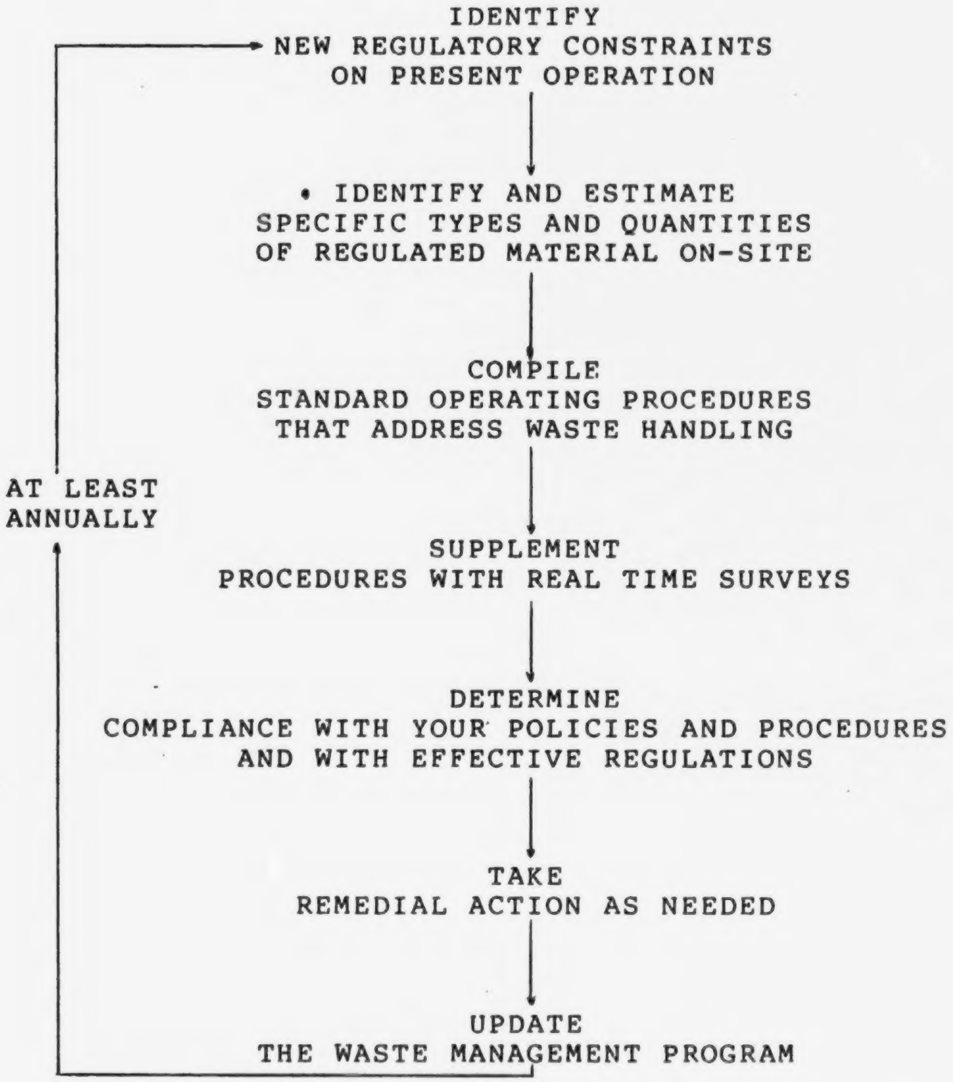

IDENTIFY
NEW REGULATORY CONSTRAINTS
ON PRESENT OPERATION
• IDENTIFY AND ESTIMATE
SPECIFIC TYPES AND QUANTITIES
OF REGULATED MATERIAL ON-SITE
COMPILE
STANDARD OPERATING PROCEDURES
THAT ADDRESS WASTE HANDLING
AT LEAST
ANNUALLY
SUPPLEMENT
PROCEDURES WITH REAL TIME SURVEYS
DETERMINE
COMPLIANCE WITH YOUR POLICIES AND PROCEDURES
AND WITH EFFECTIVE REGULATIONS
TAKE
REMEDIAL ACTION AS NEEDED
UPDATE
THE WASTE MANAGEMENT PROGRAM

FIGURE 6

COMPLIANCE EVALUATION PROCESS
(FINDLEY, 1985)

USEPA-designated Class I wells]." In relation to this statement, ground water contamination, ground tremors, and blow-outs resulting from deep-well disposal were discussed. These incidents were reportedly caused by improper technology, a lack of safety equipment, the use of incorrect drilling procedures and injection rates, and the use of tubing that was incompatible with the waste that was being injected.

Congressman James J. Florio (1984) stated that land disposal is a shortsighted approach since a facility cannot be built to contain waste for as long as that waste can pose a risk to public health. He believes that alternative forms of disposal, although safer, are being underutilized. These include waste reduction, recycling, and proper treatment (e.g., incineration and hydrolysis).

The American Chemical Society, or ACS, (1984) offers a hierarchy that outlines the alternative methods for managing hazardous waste. Reduction, also referred to as "pollution prevention,""no waste/low waste," and "source reduction," involves minimizing waste at the source. This method attempts to eliminate the waste by not generating it in the first place. Reuse or recycling of a waste is the second choice for disposal. Reuse is the recovery and direct use of a material whereas recycling requires treatment before it can be used. The third choice is treatment, which has been described by the ACS (1984) as "any physical, chemical, biological, or thermal process that destroys, detoxifies, or neutralizes hazardous wastes, reduces their volume, or makes the wastes amenable to recovery, storage, or transport." Although it is likely that land disposal will always be used for the disposal of wastes, ACS recommends that this method of disposal be avoided if alternatives are available. Land disposal is the last method of choice in the hierarchy ACS considers "optimal."

Skinner (1985) states that there is a strong presumption against land disposal and a strong preference for treatment and destruction methods. Although Knott (1985) agrees with this, he adds that "As more and more materials are banned from land disposal, a greater degree of engineering and design is being devoted to the safe landfilling of those wastes still acceptable for landfilling." This movement has increased the demand for approved hazardous waste incinerators. Unfortunately, the number of those incinerators in operation is declining. Anderson (1985) reports that only six percent of the hazardous waste generated annually in the United States is disposed of in commercial incinerators.

A number of colleges and universities have in-house programs designed to dispose of their chemical wastes using many of the methods discussed above. For instance, The Ohio State University (Schultz, 1983, 1985), the University of Minnesota (n.d.), and the University of Alberta (Armour, 1984) have written procedures for the disposal of specific wastes generated in the laboratory. Although not prepared at a college or university, the Manufacturing Chemists Association (1972), Corbin (1980), the National Research Council (1983) and others have published similar procedures.

CHAPTER III

METHODS

Revising the Management of Chemical Waste

In an effort to test the hypothesis of this study, a proposal to revise the chemical waste management procedures at SUNY-Binghamton was prepared and submitted by the author of this thesis to the university administration in November, 1985 (Appendix B, page 113). Based on information that was obtained during this study and from the literature reviewed, an economically practicable program was designed to reduce the volume of hazardous waste disposed of by SUNY-Binghamton and to minimize any present and future threat to human health and the environment from that waste. This proposal was approved and implementation of the program began on December 1, 1985. The Chemical Waste Management (CWM) Program consists of the following three sections: the generator section; the recycling section, and the disposal section.

Generator Section

Chemical waste is generated by most laboratories, support trades shops, and other groups that use chemicals or chemical products in their day-to-day operations. The generator section addresses methods of collection in and removal from the areas that produce chemical waste. This waste must be collected and stored in a manner that minimizes risk to human health and the environment until it can be accepted by the CWM Program.

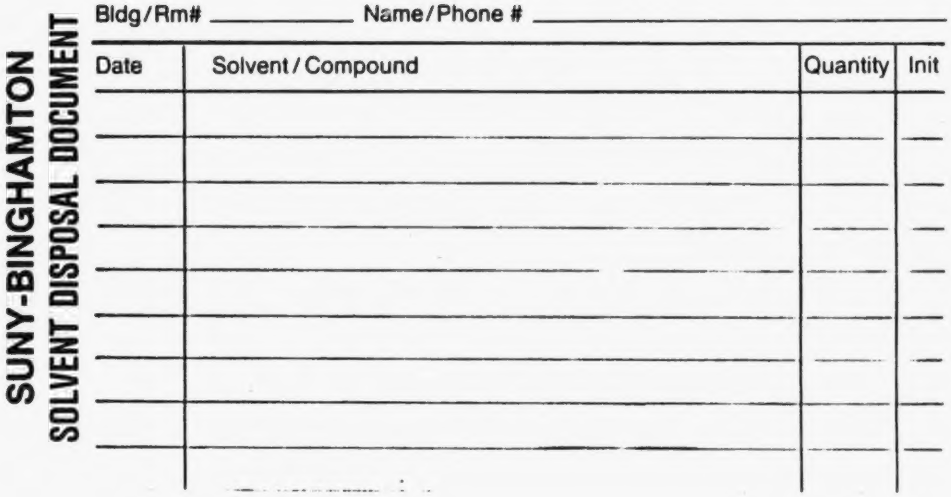
University policy states that it is the responsibility of the supervisor or manager of an area to insure that chemical wastes are properly disposed; therefore, policy has established a liaison between the generators of chemical waste and the CWM Program. However, since this responsibility is commonly delegated to subordinates such as the laboratory technicians, research assistants, painters, mechanics, machinists, photographers, print/copy personnel, and custodians, these persons will play an important role in the generator section. The generator section provides assistance in determining the following: 1) the method or methods of collection that best suit the needs of the generator; 2) laboratory disposal techniques for specified chemical wastes; and 3) procedures for the removal of chemical wastes from the generator's area.

The generator section does not differentiate between hazardous waste and non-hazardous chemical waste. Although it is possible for laboratories to dispose of specific wastes themselves such as buffers, low concentrations of aqueous waste streams, and dilute mineral acids, the hazardousness of a waste may depend on the quantity of that waste being disposed. Therefore, in an effort to regulate the disposal of chemical wastes campus-wide, disposal by individuals or groups that produce the waste is discouraged.

Two basic chemical waste categories are used. The first is solvent waste and includes gasoline, paint thinners, organic solvents, and certain aqueous wastes suitable for bulking. As a safety precaution, a recommendation was made to collect and store solvent waste in Factory Mutual, or FM-approved safety containers (a specially designed container for flammable liquids). Given the cost of these containers, laboratories generating small quantities of solvent waste (less than one gallon each week) may continue to collect their solvent waste in one-gallon or four-liter glass solvent bottles until an economically acceptable alternative is found.

A pre-printed 3-inch by 5-inch tag (SOLVENT DISPOSAL DOCUMENT) is used to identify the name, location, and telephone number of the laboratory and responsible party (Figure 7, page 57). The tag, attached by a string to each container, serves as a temporary log and is used to list the contents of each container by compound and quantity. It is designed to allow for numerous additions to any given container, identifying the date the waste is added and the initials of the generator disposing the waste.

Directives for solvent waste disposal (Figure 8, page 58) were developed as part of the CWM Program and are provided to standardize collection procedures and documentation. When making waste entries on a tag, the common or International Union of Pure and Applied Chemistry (IUPAC) nomenclature must be used. In order to simplify record keeping, it is requested that mixtures be listed in component quantities (e.g., 750 milliliters of 50:50 methanol:t-butanol would be written as "375 milliliters of methanol" on one line and "375 milliliters of t-butanol" on another). The directives note that water is a solvent and must be accounted for in the documentation.



SUNY-BINGHAMTON
SOLVENT DISPOSAL DOCUMENT

Bldg/Rm# __________ Name/Phone # ____________________

Date	Solvent/Compound	Quantity	Init

FIGURE 7

SOLVENT DISPOSAL DOCUMENT
CHEMICAL WASTE MANAGEMENT PROGRAM

DIRECTIVES FOR SOLVENT WASTE DISPOSAL

Inventory

A 3" by 5" tag will be attached to each solvent waste container. The generator of the waste will use this tag to:

1. Identify the building and room number where the waste was generated.
2. Identify a responsible party who can be contacted as a generator representative.
3. List the solvent name and quantity of waste each time it is added to the container. Common or IUPAC nomenclature should be used. Please estimate the quantity in milliliters. For mixtures, estimate component quantities (e.g., 750 ml of 50:50 methanol: t-butanol would be written as 375 ml methanol on one line and 375 ml t-butanol on another).
4. Initial your entry.
5. Please write legibly.

NOTE: Water is a solvent and must be accounted for in your solvent waste listings.

Laboratories generating solvent waste have the responsibility of identifying all compounds and quantities in the container. Estimate "trace" amounts in grams or milliliters.

Pick-up requests are made through this office by calling the Chemical Waste Manager at x2211.

Any and all persons generating a chemical waste have a moral and legal obligation to certify that their waste has been properly disposed. Improper disposal can result in injury to life and health and may be punishable by a maximum of seven years in prison or a $100,000 fine, or both.

Questions regarding these procedures should be directed to The Division of Occupational Safety and Health at x2211.

4-86

FIGURE 8

DIRECTIVES FOR SOLVENT WASTE DISPOSAL

The second waste stream includes all other types of chemical waste. Directives for chemical waste disposal were developed as part of the CWM Program and are provided to ensure correct segregation, waste packaging, and documentation (Figure 9, page 60). Wastes are first segregated into their compatible classes, i.e., acids, bases, flammables, poisons, oxidizers, reducers, and reactives. (It should be noted that solvent waste is accepted in this waste stream. The procedures for solvent waste disposal discussed above are intended for a larger, more constant generation of that type waste). After making certain that the containers holding the waste (the primary containers) are not broken, leaking, or otherwise unable to securely hold their contents, they are placed into a sturdy box (the secondary container) and surrounded with enough packing material to prevent breakage during transport.

The room and building where the waste was generated is indicated on the secondary container. Each waste pick-up is documented on a 8.5-inch by 11-inch form (CHEMICAL WASTE DOCUMENT) that identifies the date and location of the pick-up, the name of the party responsible for the waste, and a telephone

DIRECTIVES FOR CHEMICAL WASTE DISPOSAL

All wastes should be identified and segregated as follows:

1. Explosive or unstable
2. Gaseous
3. Corrosive acid
4. Corrosive base
5. Flammable
6. Poisonous/Infectious (carcinogens)
7. Oxidizer
8. Reducer
9. Water or air reactive

All chemicals must be in a primary container that is labelled and leak proof. The primary containers must be placed in a box or other container and protected from each other by a suitable packaging material (preferably newspaper). Each box or secondary container must clearly identify the room, building, and name of the waste generator.

An inventory of the chemical waste will be made and listed on a CHEMICAL WASTE DOCUMENT, available through this office. Use common or IUPAC nomenclature, estimate quantities in grams or milliliters, and identify waste class (e.g., acid, base, poison, etc.).

Pick-up requests are made through this office by calling the Chemical Waste Manager at x2211.

ALL RADIOACTIVE WASTES ARE HANDLED BY RADIATION SAFETY x2857.

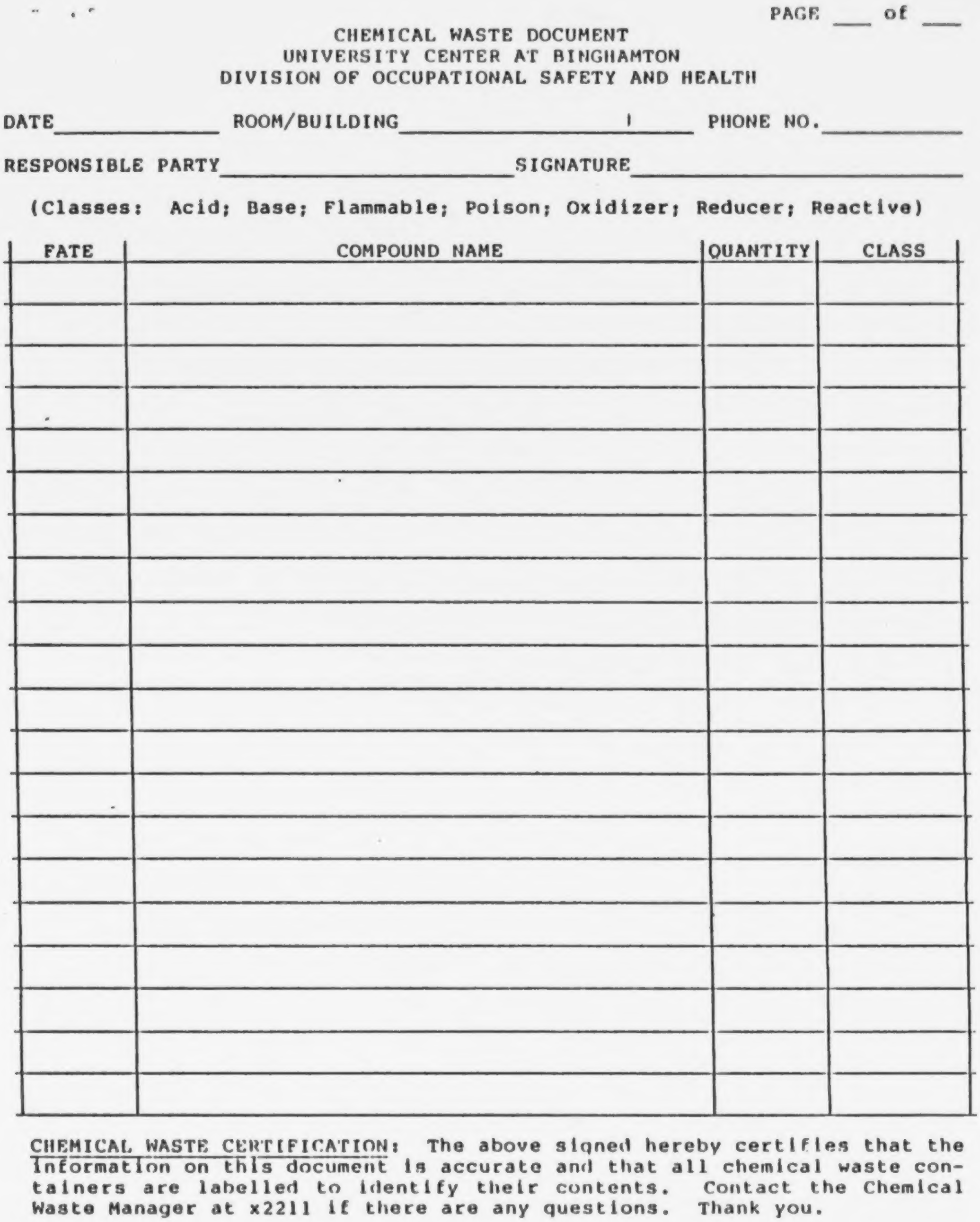
Any and all persons generating a chemical waste have a moral and legal obligation to certify that their waste has been properly disposed. Improper disposal can result in injury to life and health and may be punishable by a maximum of seven years in prison or a $100,000 fine, or both.

Questions regarding these procedures should be directed to The Division of Occupational Safety and Health at x2211.

4-86

FIGURE 9

DIRECTIVES FOR CHEMICAL WASTE DISPOSAL



PAGE ___ of ___

CHEMICAL WASTE DOCUMENT
UNIVERSITY CENTER AT BINGHAMTON
DIVISION OF OCCUPATIONAL SAFETY AND HEALTH

DATE____________ ROOM/BUILDING_________________ | _____ PHONE NO.__________

RESPONSIBLE PARTY____________________ SIGNATURE__________________________

(Classes: Acid; Base; Flammable; Poison; Oxidizer; Reducer; Reactive)

FATE	COMPOUND NAME	QUANTITY	CLASS

CHEMICAL WASTE CERTIFICATION: The above signed hereby certifies that the information on this document is accurate and that all chemical waste containers are labelled to identify their contents. Contact the Chemical Waste Manager at x2211 if there are any questions. Thank you.

CWD 2-86

FIGURE 10

CHEMICAL WASTE MANAGEMENT PROGRAM
CHEMICAL WASTE DOCUMENT

number where someone in that party can be reached (Figure 10, page 61). The name of each chemical is listed by compound name and its quantity estimated. To maintain standard procedure, the common or IUPAC name must be used. The hazard classification should be indicated if known. This document is also used to indicate the fate, or the disposal method, of the waste. This can include pouring into a drum, neutralizing, oxidizing, reducing, evaporating, lab packing, and recycling.

At the bottom of every chemical waste document is a certification statement that reads:

> The above signed hereby certifies that the information on this document is accurate and that all chemical waste containers are labeled to identify their contents. Contact the Chemical Waste Manager at xxxx if there are any questions. Thank you.

The responsible person is required to read this statement and sign the document.

Given the hazards associated with the transportation of chemicals, the generator section provides pick-up of the waste when requested. However, the Chemistry and Biology Departments provide chemical waste coordinators that serve as a liaison between the Chemical Waste Manager and the waste generators in their respective departments. In preparation for pick-up by DOSH, most of the wastes are collected by the coordinators.

At no time are unknown chemical wastes accepted into the program. Unknown chemical wastes are those chemicals that are unlabeled or obviously mislabeled. However, since the intent of the program is to dispose of chemical waste, assistance in determining the identity or classification of the unknown is offered to the generator.

Recycling Section

The pick-up, transportation, and determination of the fate of chemical wastes are addressed in the recycling section. All pick-ups and transportation are carried out by the chemical waste manager. When necessary, assistance is provided by other DOSH personnel.

Solvent waste not suitable for in-house recycling is poured into USDOT-approved type 17E 55-gallon drums. This bulking process is performed in the waste chemical shed, which is an explosion-proof room dedicated for this purpose.

The solvent waste document is removed from the container before pouring. The date of pouring, the number of the drum the solvent waste is poured into, and an estimate of the quantity of the solvent poured is written on the document. These data are consolidated and recorded by drum number, date of pouring, and generator location in a log book (Appendix C, page 127).

During the pouring operation, care is taken not to overfill the drums. A two-to-three inch head space is maintained in each drum to accommodate expansion of the liquid.

Oils are accumulated in the shed. This waste is eventually transported to maintenance and added to a storage tank where used oil generated by the garage is stored. As discussed above, waste oil is given to a local private company that blends and uses it as a fuel for heat recovery purposes.

Spent photographic waste is poured into drums for storage. Given the high content of silver in the fixer, a large film manufacturing company in the area accepts this material and adds it to its waste stream.

All other chemical waste is taken to a laboratory and segregated according to its hazard category and its potential for recycling or in-house disposal. The date the waste was picked up is written on each container. Any container of waste can then be located in the chemical waste documentation which is filed in reverse chronological order (Appendix D, page 132). Any chemical having an immediate or potential use on campus or having the potential to be recycled by a private company will be considered a recyclable. Chemicals that are molecularly stable, not contaminated, and have sealed containers will be placed in storage and the name of the chemical compound is listed for reference. This list is referred to when someone calls and inquires about the availability of a given compound from the CWM Program.

Disposal Section

Disposal is the final operation in the chemical waste management process. The method that is used to dispose of a chemical waste is dependent on how it was evaluated in the recycling section.

As the final step in processes using mineral acids, mineral bases, and certain oxidizers, the pH of these chemicals are adjusted through neutralization techniques. In a laboratory fume hood, acids are first diluted by adding them to cold water in a 15-gallon vat. Waste bases are then slowly and cautiously added to the acid solution, stirring often. Certain oxidizing compounds (e.g., phosphorous pentoxide and sodium perchlorate) are added to ice water and neutralized as above. When the neutralization is complete, the reaction medium is checked with pH paper to verify a pH range of 5 to 9. The reaction medium is finally flushed down the drain with copious amounts of cold water.

If the acid waste contains hexavalent chromium--potassium dichromate or chromium trioxide are examples and are known human carcinogens as identified in the National Toxicology Program's Fourth Annual Report on Carcinogens: Summary 1985 (1986)--it is necessary to reduce the valence state of the chromium compound to a less hazardous state. Sodium bisulfite is added to the reaction medium to reduce the hexavalent chromium to a tri- or divalent chromium compound. Small amounts of this waste can then be disposed via the sanitary sewer system.

Chemical waste that has no immediate value to the university, cannot be recycled or reused, and cannot be disposed in-house is declared a hazardous waste. As required by law, every effort is made by the CWM Program to accomplish the following: 1) reduce the volume of hazardous waste generated by SUNY-Binghamton and 2) render the waste less hazardous before disposal. Hazardous waste is placed in temporary storage until a licensed company can transport the waste off campus and dispose of it.

The bulked solvent waste is declared a hazardous waste if it cannot be recycled or reused. The drums are appropriately labeled in accordance with NYSDEC and USDOT hazardous waste regulations. Temporary storage of this waste is provided in the waste chemical storage shed.

Formalin is poured into a dedicated 55-gallon drum and a record is kept in the solvent log. Although this chemical is basically used for preserving specimens in the biological sciences, it is received in quantities of one to ten gallons; therefore, it is more convenient to handle formalin as a solvent waste.

Hazardous Waste Disposal

Given the strict state and federal regulations that address the handling, transportation, and disposal of hazardous waste, a reputable, full-service chemical waste disposal company was chosen to dispose of the hazardous waste generated during this study. A material profile sheet describing each waste stream was required by the company. Each completed profile sheet contained the following information: generator identification and information; physical data on the waste including appearance, flash point, specific weight, pH, and precipitated solids; specific constituents of the waste such as free cyanide, free sulfide, PCBs, and dioxin; reactivity and the by-products generated, if any; the chemical make-up of the waste and in what percentage; total metals in parts per million (ppm); waste container type; and the appropriate USEPA and New York State waste codes.

Four material profile sheets were prepared and submitted to the company (Appendix E, page 137). The profile sheets represented bulked wastes that were generated by SUNY-Binghamton in quantity--halogenated solvent waste, non-halogenated solvent waste, waste toluene (as paint thinner), and waste formalin. The profile sheets did not address the reactive, toxic, and flammable wastes that were generated during the study period but could not be bulked with the solvent waste stream. Therefore, a list identifying the remaining hazardous wastes was sent to the company. This list was used by the company to approve the wastes for lab packing and subsequent disposal.

CHAPTER IV

RESULTS

Generation

Implementation of the revised chemical waste management program was accomplished by delivering the Directives for Solvent Waste Disposal and the Directives for Chemical Waste Disposal to known and probable generators of chemical waste. Those individual laboratories generating higher, more consistent volumes of waste were visited and the program was discussed in person.

Although FM-approved safety containers were recommended for the collection of solvent waste, the short-term costs were prohibitive and they could not be purchased. Therefore, solvent waste was received in an assortment of containers, typically the one-gallon and four-liter glass bottles.

Solvent Disposal Documents, referred to as solvent tags, were usually tied to the bottles that were received, listing the solvents contained in the bottle. A few waste bottles were found to have the MP 808 three-part form attached. Since these forms were no longer being circulated, they were considered a part of the transitional phase and were accepted into the revised program. When an old form was received, however, it identified a person not totally familiar with the CWM Program. Therefore, the person using the old form was contacted and the directives of the new program were discussed.

Unfortunately, due to the simplicity of the solvent tags, many bottles containing aqueous waste (e.g., acids, heavy metal salts in solution, etc.) were received with these tags attached. The waste information was transferred onto a Chemical Waste Document and the generator was contacted to clarify document use.

Between December 1, 1985 and November 30, 1986, a total of 125 chemical waste pick-ups were made across campus. About 500 bottles--the majority of these bottles were one-gallon, four-liter, and five-pint sizes--and 17 five-gallon containers were transported and handled as solvent waste. Forty-nine chemical waste documents were filed with 202 entries of chemical wastes. Types of waste included flammable liquids and solids, corrosive acids, corrosive bases, toxic materials, water-reactive compounds, shock-sensitive compounds, and innocuous chemicals.

Recycling

Given the relatively low volume generation of solvent waste, the segregation of specific solvents for recycling would not have been cost effective. Furthermore, the solvent waste received by the program was a mixture of many solvents.

A total of 800 gallons of solvent waste was bulked into 55-gallon drums. Toluene, which is used as paint thinner in maintenance, made up 250 gallons of the total, formalin accounted for 80 gallons, polyethylene glycol accounted for 50 gallons, and the remaining 420 gallons were from the science and fine arts laboratories.

Over 10 percent of the poisons (16.7 pounds) and 100 percent of the oxidizers (118 pounds) were recycled into the program and used for chemical reactions in-house.

Due to limited funds, lists of recyclable chemicals were not produced for campus distribution. Nevertheless, word-of-mouth and close contact with chemical waste generators (i.e., those individuals and groups who use chemicals) allowed for some limited activity in recycling. Based on the retail cost of the chemical compounds found in a random selection of current chemical company catalogs, the purchase of nearly $200 worth of chemicals was avoided. An unwanted drum of usable polyethylene glycol (PEG) was provided to an individual, thus avoiding disposal costs. Cost avoidance savings for the study period, without a structured in-house recycling program, totaled nearly $400.

Disposal

During the study period, two hazardous waste pick-ups were made by a chemical waste disposal company. Two company representatives, called "road chemists," were responsible for the handling and transport of the waste. The road chemists visually inspected the contents of the 55-gallon drums of solvent waste and compared each with the information on the material profile sheets.

The chemicals that were identified by the list sent to the company were packed by the road chemists according to hazard classification or chemical compatibility. Compatible wastes that could be destroyed by incineration were lab packed in a

20-gallon combustible fiber drum. The remainder of the waste was further segregated and packed separately into 5-gallon pails for subsequent treatment.

Four hundred gallons of solvent waste were burned for heat recovery purposes. Approximately 14 pounds of flammables were lab packed in a fiber drum and incinerated. Twenty-three pounds of reactive compounds were segregated and lab packed into six 5-gallon pails for destruction by hydrolysis/ incineration.

One 55-gallon drum of formalin was solidified by pumping one-half the contents of the drum into a second drum and adding about 450 pounds of absorbent material to both. This resulted in two 55-gallon drums of solidified waste that was buried in a secure landfill.

Manifests and other required permits and licenses carried by the waste hauler were inspected for accuracy, applicability, and validity. By law, if these items were not current or correct, the hauler and the generator would be liable and held accountable for any infraction.

In-house disposal, considered a final step in the laboratory process, was limited to the elementary neutralization of acids, bases, and other choice oxidizing materials. All the corrosive acids (282 pounds) and most of the corrosive bases (54 pounds) received by the program were neutralized to a non-hazardous state and disposed in the sanitary sewer system.

CHAPTER V

DISCUSSION

The generation of chemical waste at SUNY-Binghamton, in terms of quantity and type, fluctuated with the following: 1) the amount and type research performed; 2) maintenance paint shop activity; 3) the number of students enrolled in courses that generate chemical waste; 4) changes in laboratory methods, and 5) researchers leaving the university or deciding to reduce the chemical burden in their research area(s).

The licensed disposal company did not pick up all the hazardous waste that was generated in the study period. The majority of the waste received for disposal by the program was solvent waste and it was generated in relatively small volumes over time. Since the method of collection was bulking into 55-gallon drums, the volume of waste collected after the last hazardous waste pick-up did not justify additional pick-ups by the disposal company.

Furthermore, the disposal of the formalin by landfilling did not reflect the preferred disposal method by the program. Unfortunately, the company that usually accepted this type waste stream for incineration was experiencing undetermined problems and could not accept the formalin. The only other short-term disposal alternative at that time was solidification and landfilling.

Discussion of Hypothesis

The methods used to test the hypothesis of this thesis stated in Chapter I were measured, in part, by the volume of hazardous waste generated at SUNY-Binghamton. The common measure used was the 55-gallon drum (Table 3, page 78). Volumes of waste have been converted to 55-gallon drum equivalents (de). A lab packed drum destined for a secure landfill consists of 15 one-gallon, four-liter, or five-pint bottles containing waste. A 20-gallon lab pack fiber drum destined for incineration was considered 0.4 drum (de). Three lab packed 5-gallon pails were considered to equal one drum (de). A bulked 55-gallon drum consists of fifty gallons of solvent waste. Bottles containing waste were also given a common measure--the one-gallon equivalent (ge). A five-gallon container equals 6 one-gallon bottles (ge). Four bottles of varying sizes equal a one-gallon bottle (ge).

TABLE 3

HAZARDOUS WASTE CONTAINER VOLUMES CONVERTED TO COMMON EQUIVALENTS

COMMON MEASURE

55-GALLON DRUM = 1 DRUM EQUIVALENT (de)
1-GALLON CONTAINER = 1 GALLON EQUIVALENT (ge)

SIZE/ CONTAINER	NUMBER OF CONTAINERS	EQUIVALENT MEASURE
20-GALLON LAB PACK FIBER DRUM	1	0.4 (de)
5-GALLON PAIL	3	1 (de)
50-GALLONS BULKED IN A 55-GALLON DRUM	1	1 (de)
ONE-GALLON, 4-LITER, OR 5-PINT BOTTLES	15	1 (de)
5-GALLON CONTAINER	1	6 (ge)
ONE-LITER OR LESS VARIOUS-SIZED BOTTLES	4	1 (ge)
4-LITER BOTTLE	1	1 (ge)
5-PINT BOTTLE	1	1 (ge)

It was hypothesized that the volume, related costs, and potential long-term liability associated with the disposal of hazardous waste could be effectively reduced at SUNY-Binghamton by:

1. Identifying and segregating non-hazardous waste from chemical waste that would be considered a hazardous waste if discarded.

If the chemical waste received by the CWM Program: 1) was a listed hazardous waste, or 2) exhibited one of the four characteristics of a hazardous waste, or 3) was a mixture of a solid and listed hazardous waste, and 4) was not reusable or recyclable, it was declared a hazardous waste and destined for disposed as such. However, if the chemical waste did not meet the above qualifications, it was segregated from the rest of the waste. Wastes that were reusable were placed in storage for redistribution to persons on campus. If they were non-hazardous chemicals, they were disposed via the sanitary sewer system or placed in hard trash for burial in the local sanitary landfill.

The volume reduction achieved through these redistribution efforts totaled 48.75 gallons (ge) and

1 drum (de). As reported above, the purchase of nearly $200 worth of chemicals and about $200 in disposal costs were avoided by the program's limited recycling efforts.

2. Bulking solvent waste in 55-gallon drums.

Bulking the solvent waste generated by the science complex was by far the most effective method of volume reduction. It must be understood that when lab packing under MP 808 guidelines, 15 one-gallon bottles of waste are placed into a 55-gallon drum with no regard to the volume of waste in the bottle. This means that a lab packed drum should not be compared to a bulked drum on a per-gallon basis (i.e., 15 one-gallon bottles of waste do not necessarily equate to fifteen gallons of waste). The methods of packaging, however, compare by the number of drums disposed and by the method of disposal.

The solvent waste received from the science complex totaled 420 gallons. Bulking this waste produced 8.4 drums (de) of solvent waste.

Formalin, even though it was bulked by both programs, was disposed by different methods. MP 808 disposed of formalin using deep-well injection. Even though no direct long-term liability exists, this disposal method is controversial regarding the potential adverse environmental effects on ground water. As discussed above, one drum of bulked formalin was solidified to produce two drums of a non-specified toxic waste and was buried in a secure landfill. This disposal method, although at a greater cost than incineration, was considered more environmentally sound than deep-well injection.

The Paint Shop collected their solvent waste (toluene) in 55-gallon drums. It was, therefore, already bulked when received by the CWM Program.

3. Rendering corrosive acids and bases non-hazardous by using elementary neutralization methods as the final step in laboratory processes using these chemicals.

Acids and bases received by the CWM Program totaled 30.25 gallons (ge) and 9.75 gallons (ge), respectively. Neutralization of these wastes reduced the volume of hazardous waste by 3.3 drums (de).

Extrapolation of Results

Using the detailed invoices from the two hazardous waste pick-ups that occurred during the study period and the price list of services offered by the disposal company, a break-down of costs for labor, disposal, transportation, and associated materials was determined (Table 4, page 82). This information was used to compare the total volume of hazardous waste generated and the overall disposal costs of that waste using MP 808 and the CWM Program (Table 5, page 83). Note that all references to 55-gallon drums are in drum equivalents (de) unless otherwise indicated.

Materials - The CWM Program required a wider variety of packaging materials as compared to that required by MP 808. For example, lab packing for incineration required a combustible 20-gallon fiber drum. The packing material used to pack around the bottles of waste in this drum was an absorbent made from corn cobs which is also combustible. The unfortunate need to solidify a 55-gallon drum of formalin necessitated the use of a clay absorbent (fuller's earth) and double the drummage under the CWM Program.

TABLE 4

FEES AND ASSOCIATED DISPOSAL COSTS
GSX SERVICES, INCORPORATED
(AS OF JULY 1986)

ITEM	COST	COMMENTS
MATERIALS		
55-GAL. DRUM.....	$ 30.00	EACH, DOT 17E, 17H
20-GAL. DRUM.....	15.00	EACH, FIBER
5-GAL. PAILS.....	8.50	EACH
VERMICULITE......	8.00	BAG, 1.5 BAGS/55-GAL. DRUM
CORN COB PACKING.	8.00	BAG, 1 BAG/20-GAL. DRUM
ABSORBENT........	7.50	BAG, 4 BAGS/55-GAL. DRUM
DRUM TRANSPORT		
S/H..............	$ 25.50	PER 55-GAL. DRUM EQUIV.[1]
LABOR		
ROAD CHEMIST.....	$ 45.00	PER MANHOUR 1 MANHOUR/LAB PACKED DRUM 1/2 MANHOUR/BULKED DRUM
PPE..............	15.00	PER MAN/DAY
DISPOSAL METHOD		
INCINERATION.....	$137.50	PER BULKED 55-GAL. DRUM
INCINERATION.....	196.00	PER LAB PACKED 20-GAL. DRUM
REACTIVES........	49.00	PER POUND
SECURE LANDFILL..	137.50	PER 55-GAL. DRUM
DEEPWELL INJ.....	164.50	PER 55-GAL. DRUM

[1] Shipping and handling equivalents:
Three 5-gallon pails = one 55-gallon drum
One 20-gallon fiber drum = one 55-gallon drum

TABLE 5

COST COMPARISON
MP 808 v. CWM PROGRAM
NOVEMBER 30, 1985 TO DECEMBER 1, 1986

	MP 808		CWM PROGRAM	
ITEM	AMT.	COST	AMT.	COST
55-GAL. DRUMS....	63.1	$ 683.20	17.3	$ 519.00
20-GAL. DRUMS....	----	----	1.9	28.50
5-GAL. PAILS.....	7.0	59.50	7.0	59.50
VERMICULITE......	85.4	683.20	1.1	8.40
CORN COB PACKING.	----	----	1.9	15.20
ABSORBENT........	----	----	6.4	48.00
MATERIALS SUBTOTAL		2,635.70		678.60
LABOR-LAB PACKING	56.9	2,560.50	5.4	264.60
LABOR-BULKED.....	4.3	193.50	6.7	301.50
PPE-MANDAYS......	16.0	240.00	4.0	60.00
LABOR SUBTOTAL		2,994.00		626.10
INCINER.-BULKED..	6.9	948.75	13.4	1,842.50
INCINER.-LAB PACK	----	----	1.9	372.40
REACTIVES........	24.6	1,205.40	24.6	1,205.40
SECURE LANDFILL..	54.6	7,507.50	3.9	536.25
DEEPWELL INJ.....	1.6	246.75	----	----
DISPOSAL SUBTOTAL		9,910.65		3,956.55
S/H SUBTOTAL	65.4	1,667.70	21.5	548.25
TOTAL DISPOSAL COSTS		$17,203.55		$5,809.50

Bulking solvent waste reduced the amount of the 55-gallon drums used from 63.1 drums to 17.3 drums. Lab packing for secure landfilling required the use of vermiculite, a lightweight mineral-based absorbent. Over 85 bags were necessary to lab pack the waste using MP 808 compared to 1.1 bags under the CWM Program.

The savings in material costs using the CWM Program was $1,957.10 (a 74 percent reduction).

Labor - Labor costs take into account the time that the private disposal company is involved with the following: 1) actually packing a drum for landfilling or incineration; 2) subjectively comparing the contents of a bulked drum to the information on the respective waste material profile sheet; 3) completing the documentation for each drum; and 4) handling each drum which includes securing it for transport and loading it onto the truck.

The fees that cover the personal protection equipment (PPE) used by the road chemists are based on the use of the equipment per person per day. For example, if two road chemists were to complete their task in only 2 hours, the charge for the PPEs would be the fee X 2 (workers) X 1 (day), or 2 worker-days, even though only 4-manhours were used. The equipment used must be cleaned or disposed of after each day's work regardless of how many hours it was used.

It would have taken two road chemists nearly eight 8-hour days to complete the hazardous waste pick-up using MP 808. The CWM Program required about two 8-hour days. The savings from charges associated with labor using the CWM Program were $2,367.90 (a 79 percent reduction).

Disposal - Both the MP 808 and the CWM Programs utilized methods of disposal that were legally acceptable during the period in which the comparison was based. MP 808, however, does not address lab packs for incineration. The CWM Program considers disposal by deep-well injection to be the least acceptable method with more environmentally sound methods of disposal available. MP 808 generated nearly 55 drums (de) destined for a secure landfill compared to less than 4 drums (de) generated by the CWM Program. This can be viewed as a drastic reduction in the long-term liability associated with the waste lab packed and placed in a secure landfill.

Disposal methods used by the CWM Program reduced the cost of disposal 60 percent ($5,954.10).

Shipping and Handling - The chemical waste disposal company provides a service for clients that generate hazardous waste in less-than-truck-load quantities. A charge per-drum is assessed based on the distance from the pick-up location to the company's facility. The $25.50 per-drum fee is based on a 200- to 500-mile distance from SUNY-Binghamton.

The drums (de) shipped using MP 808 totaled 65.4 drums (de) whereas the CWM Program shipped less than 22 drums (de), a reduction of 67 percent. Cost savings exceeded $1,119.00.

Overall Comparison

The volume of hazardous waste generated by the CWM Program was 21.5 drums (de) compared to 65.4 drums (de) using MP 808, a reduction of 67 percent. The costs associated with disposing that waste was $5,809.50 using the CWM Program and $17,203.55 using MP 808, a savings of $11,394.05 and cost reduction of 66 percent. Long-term liability, on a per-drum basis, was reduced nearly 93 percent.

CHAPTER VI

SUMMARY AND CONCLUSIONS

A study was made of the policies and procedures addressing chemical waste at the State University of New York at Binghamton (SUNY-Binghamton). The objectives of the study were: 1) to gain an understanding of the present policies and procedures addressing waste chemicals at SUNY-Binghamton; 2) to evaluate the management of that waste in terms of handling and disposal; and 3) to serve as a basis for any modifications to the program that may be implemented in an effort to reduce the volume and associated costs for disposal of waste chemicals at SUNY-Binghamton.

The study revealed that chemical waste managed under Management Procedure Number 808 (MP 808) was disposed of as hazardous waste regardless of whether it met the legal definition of a hazardous waste. Waste was typically received by the Department of Occupational Safety and Health (DOSH) in glass

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bottles and eventually lab packed in 55-gallon drums for disposal. The disposal method used for the majority of the waste was burial in a secure landfill. This method does not destroy the waste and presents a long-term liability to SUNY-Binghamton if that waste should ever be released into the environment.

It was hypothesized that the volume, related costs, and the potential long-term liability associated with the disposal of hazardous waste could be effectively reduced at SUNY-Binghamton by: 1) identifying and segregating non-hazardous waste from chemical waste the would be considered a hazardous waste if discarded; 2) bulking solvent waste in 55-gallon drums; and 3) rendering corrosive acids and bases non-hazardous by using elementary neutralization methods as a final step in processes using these chemicals.

The existing MP 808 was modified, becoming the chemical waste management (CWM) Program. Implementation began in November 1985. Directives were written addressing two distinct waste streams--solvent waste and other chemical waste.

Documentation was improved to make it easier for generators to keep a log of their solvent wastes while collecting it. This waste stream was poured together into a common 55-gallon drum (bulked). The document used for chemical waste was simplified to reduce paper work and make the waste stream more manageable. Non-hazardous waste was removed and disposed via hard trash or the sanitary sewer system. Limited efforts were made to recycle usable chemicals in-house.

Acids and bases were neutralized as a final step in the laboratory process. Upon adjusting the pH to within a range of 6 to 10 the non-hazardous solution was flushed down the drain.

All chemical waste that was declared a hazardous waste was handled, transported, and disposed of following pertinent state and federal regulations. A licensed chemical waste disposal company was chosen to transport the hazardous waste to facilities approved by the USEPA for disposal.

To illustrate the results, a comparison of management and disposal methods was made using MP 808 and the CWM Program procedures. Chemical waste collected from November 30, 1985 to December 1, 1986 was used in the comparison. The disposal company's procedures, current fees, and associated costs were used to extrapolate the waste volume as well as the cost of materials and disposal for each program.

The CWM Program reduced the total disposal costs 66 percent, thus saving SUNY-Binghamton in excess of $11,000.00. The volume of hazardous waste disposed of was reduced by 67 percent.

It can be concluded from the results of this study that: 1) segregating non-hazardous waste from other chemical waste that may become a hazardous waste, 2) bulking solvent waste, and 3) neutralizing corrosive acids and bases in-house effectively reduced the volume, costs, and potential long-term liability associated with the disposal of hazardous waste at SUNY-Binghamton.

CHAPTER VII

RECOMMENDATIONS

The fees charged by facilities that treat, store, and dispose of hazardous waste are escalating. The increasing costs for their services are necessary for them to meet the increasing federal regulations regarding hazardous waste. As regulations addressing the generators of hazardous waste become more stringent, hazardous waste management in general is becoming a high-cost necessity.

In an effort to help provide the State University of New York at Binghamton (SUNY-Binghamton) with an acceptable yet flexible program designed to reduce the volume and costs associated with hazardous waste, and to serve in the best long-term interests of the campus community, the following recommendations are offered.

1. Revise Management Procedure Number 808. The 1983 revision does not reflect changes in procedures required by private disposal

companies, reflect new regulations that address hazardous waste, or consider the needs or restrictions of individuals, groups, or departments that generate chemical waste on campus. Furthermore, the 1983 revision places most of the procedural responsibilities on the laboratory or appointed representative. Chemical waste disposal policy should be simple, giving the generator of the waste easy-to-follow directions for the proper collection and identification of chemical waste as well as how to have it removed from the laboratory. At SUNY-Binghamton, the most common generator of chemical waste will be a research group in the Chemistry or Biological Sciences Department. Given the independence of these and other chemical waste generators in a university setting, a simple yet effective program is more likely to succeed than one requiring extensive participation by the generator(s). It is suggested that the directives established as part of this study be incorporated into a revised management procedure. In addition to offering a simple collection and identification system, the directives would not be affected by regulatory change.

2. Provide the Division of Occupational Safety and Health with a Chemical Waste Management (CWM) Program budget. The College of Arts and Sciences presently pays only for expenses incurred regarding chemical waste disposal. An "account" could be funded by surcharging all chemical products purchased by the university. A comprehensive program could then be developed to provide recommended supplies and equipment to all waste generators. This expanded service would complement program objectives.

3. Explore the potential for CWM Program interaction with academia. In the next few years, SUNY-Binghamton expects to join with new organized research centers to double external funding performance. There are plans to launch technology transfer programs and expand contacts with area industry in

conjunction with Alfred and Cornell Universities. This will undoubtedly provide for an expanded research program and an increase in the generation of chemical waste. Academia has a vested interest in providing an effective program that minimizes the potential adverse health and environmental effects of chemicals and chemical waste in the laboratory. Furthermore, the university system should serve as a model to the student, educating him or her in state-of-the-art methods and promoting independent thought to allow for the development of new and innovative methods. Students should be hired on a part-time basis to augment the CWM Program. This employment would not only provide the student with applied experience, it would allow for independent academic studies. Periodic training programs that address the proper management and disposal of chemical waste should also be provided to all faculty, staff, and students that purchase and use chemicals.

4. Develop, implement, and maintain a comprehensive chemical inventory of all chemicals at SUNY-Binghamton. Waste reduction is the elimination or reduction of waste before it is generated and is the first method of choice in managing chemical waste. A comprehensive chemical inventory would allow for inter- and intradepartmental exchange of chemicals in stock. Many chemical compounds are presently kept in laboratory storage rooms. Although they may be shared by one or two researchers, they are eventually discarded and must be disposed of at some cost. This lack of information sharing promotes the unnecessary purchase of chemicals, adds to the chemical burden, and increases the volume of chemical waste at SUNY-Binghamton. The inventory would serve as a mechanism for redistribution for many chemical compounds, thus reducing chemical waste.

5. Develop an emergency chemical spill response plan for buildings that have chemicals used in them. In the event of a spill, the chemical

and the material(s) used to clean it up are usually disposed of as a chemical or hazardous waste. Providing the proper spill response equipment and the appropriate training to insure correct clean-up procedures should reduce the magnitude of a chemical spill; thus, reducing the volume of a chemical waste.

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APPENDIX A

MANAGEMENT PROCEDURE NUMBER 808
WASTE CHEMICAL MANAGEMENT PROCEDURE

State University of New York at Binghamton
Office of Vice President
for Finance and Management

Number: 808
Date: Rev. 4/15/83

MANAGEMENT PROCEDURE

Title: WASTE CHEMICAL DISPOSAL PROCEDURE

The U.S. Environmental Protection Agency (EPA) has developed under the Resource Conservation and Recovery Act of 1976 (RCRA), a complex set of regulations to control chemical wastes. The University is currently holding a permit by the EPA as a chemical waste generator and as a treatment, storage, and disposal facility. This permit allows the University, within strict EPA and DEC guidelines, to manage all chemical wastes generated on campus. This procedure is coordinated by Mr. Frank Makein, Safety Technical Specialist in the Office of Occupational Safety and Health.

State Law (Chapter 719 of the laws of 1981) establishes criminal penalties for unlawful possession, disposal and dealing in hazardous wastes. Representation and indemnification under Section 17 of the Public Officers Law would not be available in cases of liability imposed under criminal statutes. Because of the possibilities of personal liability and prison terms, campus personnel are advised to familiarize themselves with campus procedures for storage and disposal of hazardous wastes.

Chemical wastes from academic or research laboratories, academic or trade shops and custodial services and any abandoned chemicals, out-of-date medical supplies and materials, solvents, oils, thinners, cleaning fluids and similar discards including containers shall be identified, sorted, packaged, stored and disposed of in compliance with laws and regulations of the State of New York as administered by the Department of Environmental Conservation.

All chemicals will be ultimately packaged in compatible groups (see attached) in 55 gallon drums approved by, and in the manner required by, the U.S. Department of Transportation.

The following plan outlines the procedures that will be followed to best facilitate the removal of all campus chemical waste materials.

Your cooperation in following these procedures will greatly increase the safety conditions on this campus.

PROCEDURES:

Collecting Waste Chemicals:

Each laboratory shall provide suitable, temporary containers for storage of chemicals. Waste solvents shall be collected separately according to type. Non-chlorinated hydrocarbons shall be separated from chlorinated hydrocarbons.

Waste acids and alkalies shall be collected in separate glass containers.

Solid waste chemicals shall be collected in appropriate containers which shall be labeled.

At no time should chemical wastes be left in an unauthorized area on the campus.

IDENTIFICATION:

The responsibility for the identification of waste chemicals within the University necessarily rests with the faculty and staff who have created the waste in research and instruction. Consequently, all waste containers must have attached to them the Waste Chemical Disposal Form (Form #1), which is available from individual departmental offices, as well as the Office of Occupational Safety and Health. This form contains a listing of the components of waste material, etc., as indicated thereon. The original sheet of the form is to be sent to the Office of Occupational Safety and Health via the University mail; the yellow copy is to be retained for your own departmental records; the tan copy is to be fastened to the container of waste chemical by means of a wire loop or strong tape. Waste chemical containers should be labeled as to their exact contents and quantity. (Use common chemical terminology) Unlabeled, mislabeled, or unknown waste chemicals cannot be legally disposed of, therefore these items will not be accepted.

PACKAGING

Each laboratory shall be responsible to collect waste chemicals according to compatible groups. Each accumulation of solid or liquid waste must be delivered to the chemical storage rooms for packing in drums for shipping. Complete inventories must be provided.

Again, unknown chemicals must be properly identified to be acceptable for disposal.

The University maintains a waste chemical storage shed adjacent to the Science I loading dock for the storage, packaging, and disposal of hazardous waste. Each laboratory or department should designate a person who will be responsible for delivering and handling its packaged chemical wastes. These packages will be prepared for disposal in the waste shed under the supervision of Mr. Frank Makein of the Office of Occupational Safety and Health. Employees will assist in the packaging of chemical wastes. However, that responsibility remains with the individual department itself. The waste shed will function solely as an advisory, receiving and temporary storage facility.

STORAGE AND TRANSFER

Each supervisor should maintain an inventory of hazardous material on hand. The inventory should be updated periodically and scrutinized for materials which are no longer needed, or which have exceeded their shelf life.

Storage in areas of actual use should be kept to a reasonable minimum (1-2 week's supply). Long term storage should be in separate storage areas of suitable design. Storage areas must be secure.

At least once each week (if necessary), each department shall transfer collected wastes, with the inventory, to the waste shed, where materials will be grouped and packaged in specifically designated drums. The amount and type of each waste solvent added to the 55 gallon storage drum shall be recorded.

State University of New York at Binghamton
Office of Vice President
for Finance and Management

Number: 808
Date: Rev. 4/15/83

MANAGEMENT PROCEDURE

Title: WASTE CHEMICAL DISPOSAL PROCEDURE

Waste chemicals may be brought to the waste shed on Friday mornings between 7:30 a.m. and 11:30 a.m.; they will not be accepted at any other time. Please call 2211 to arrange for a specific time to deliver your department's waste chemicals. We hope, in this way, to avoid delays, and to promote efficiency in the handling of waste materials. For a more prompt removal of chemicals, i.e. emergency situations, contact Mr. Makein at extension 2211 to make arrangements for transfer to the waste shed.

Original quality materials should be stored in their original containers. Used materials should be stored in appropriate, safe, unbreakable containers of five gallons or less. Each container must be clearly labeled as to its contents and the type of hazard must be indicated. Used materials of dissimilar characteristics should be kept in separate containers.

OTHER PROCEDURES

Radioactive materials require special treatment due to both their chemical and radiological properties. All radioactive waste is disposed of through Mr. James Brownridge's office only. Phone extension 3857.

All recoverable mercury should be returned to Mr. Richard Quest's office for salvage.

Administrators, faculty members, graduate assistants, and researchers in supervisory positions must provide information to users of potentially hazardous substances.

A user who does not have health and safety information on a desired material should request the information from the Office of Occupational Safety and Health.

Users of hazardous materials are expected to comply with the guidelines set forth in this Management Procedure.

ORDERING CHEMICAL SUPPLIES

The problem of chemical waste management begins at the time chemicals are ordered. Because large stocks of even relatively innocuous chemicals are likely to eventually create a disposal problem, order only the amount of material required to complete the project at hand. Reagents packaged in large containers may be slightly less expensive, so it becomes easy to rationalize opting for the "economy size" when the "child's plate" will do. In actuality, you may end up later with (1) an old bottle of reagent whose quality has been suspect, or (2) an immediate (and potentially expensive) disposal problem.

If you are unfamiliar with the chemical properties and hazard potential of a reagent with which you have had little or no experience, make every effort to learn something about it before using it, and preferably before ordering it. MAKE SURE YOU KNOW HOW YOU WILL DISPOSE OF ANY WASTE FROM YOUR PROJECT BEFORE YOU BEGIN THE PROJECT.

Small amounts of "common" chemicals can be obtained from Richard Quest (2208), who has a small supply of surplus chemicals.

Please remember that pouring chemicals into drains in order to dispose of them is dangerous. The office of Occupational Safety and Health may begin to monitor the sewer system for evidence of waste chemicals, if it appears the appropriate disposal procedures are being ignored.

Current departmental contacts for chemical waste disposal are the following:

Geology -- Mr. D.L. Rice

Psychology -- Ms. C. Pado

Biology -- Mr. J. Gnad

Chemistry -- Mr. R. Quest -- Until 5/1/83

Physics -- Mr. Charles D. Burr

COMPATIBILITY GROUPS

(For Packing in Separage Containers in the Same Drum)

COMPATIBILITY GROUPS:

Packaged laboratory chemicals and wastes. Groupings described below are generally considered to be compatible within that group in the event of an incident which would cause comingling of the materials within a drum. Further, in most cases, processing is facilitated, and costly repetitive handling minimized, keeping costs down, by proper grouping and identification. Examples illustrating each type of material are in parentheses.

Group A

(1) Inorganic acids (hydrochloric, sulfuric).

(2) Elements or inorganics that do not liberate gaseous products when acidified (sodium chloride, barium sulfate, magnesium nitrate).

Group B

(1) Inorganic alkaline chemicals (Sodium hydroxide, ammonium hydroxide).

(2) Organic bases (triethanolamine, pyridine).

(3) Elements and inorganics that liberate gaseous products when acidified (potassium and sodium cyanide, sodium sulfate, sodium sulfide).

(4) Heavy metals (mercury, tin, iron, copper, etc.).

Group C

(1) Solid organic compounds, excluding organic acids and bases (Pentachlorophenol glucose, waxes, and tars).

Group D

Organic liquids, including organic acids but excluding organic bases (acetone, xylene, butyric acid).

Do not mix hydrocarbons and oxygen-containing organics with chlorinated solvents.

Group E

Inorganic oxidizing agents (potassium nitrate, sodium peroxide, bromine, potassium and sodium perchlorates, persulfates, dichromates).

Group F

Solid pesticides, insecticides, fungicides.

Group G

Known and suspect carcinogenic materials.

EXCEPTIONS

The following materials are not included in the compatibility grouping. Disposal of all listed below require special handling and will be considered case by case.

(1) Shock sensitive material (mercury fulminate).

(2) Organic oxidizing agents (benzoyl peroxide).

(3) Pressurized gas cylinders (hydrogen sulfide).

(4) Water reactive materials producing heat and flame (sodium metal).

(5) Radioactive material of any type.

(6) Pathogenic or infectious materials (viruses).

(7) The following chemicals: (see attached list).

EXCEPTIONS

1) benzidine
2) bis (chloroethyl) ether
3) bis (2-chlorethyl) ether
4) 2-chloroethyl vinyl ether (mixed)
5) 3,3 dichlorobenzidine
6) 2,4 dinitrotoluene
7) 2,6-dinitrotoluene
8) 1,2 diphenylhydrazine
9) fluoranthene
10) bis (2-chloroisoproply) ether
11) bis (2 chloroethoxy) methane
12) methylchloride
13) methylbromide
14) chlorodihromethane
15) hexachlorobutadiene
16) hexachlorocyclopentadiene
17) nitrobenzene
18) N-nitrosodimethylamine
19) N-nitrosodiphenylamine
20) 3,4-benzopyrene
21) 3,4 bensofluoranthene
22) chrysene
23) acenaphthylene
24) 1,12-benzoperylene
25) fluorene
26) phenanthrene
27) indeno (1,2,3,-C,D) pyrene
28) pyrene
29) (TCDD) 2,3,7,8 tetrachlorodibenzo p-dioxin
30) vinylchloride
31) aldrin
32) dieldrin
33) chlordane
34) 4-4' DDT
35) 4-4' DDE
36) 4-4' DDD
37) -endosulfan
38) -endosulfan
39) endosulfan sulfate
40) endrin
41) endrin aldehyde
42) heptachlor
43) heptachlor epoxide
44) -BHC
45) -BHC
46) lindane
47) d-BHC
48) toxaphene
49) mirex
50) kepone
51) 11,12 benzofluoranthene

APPENDIX B

UNIVERSITY CORRESPONDENCE REGARDING THE REVISION OF THE WASTE CHEMICAL MANAGEMENT PROGRAM

STATE UNIVERSITY OF NEW YORK AT BINGHAMTON

Binghamton, New York 13901

Department of Occupational
Safety and Health
Telephone (607) 798-2211

November 27, 1985

Mr. Walter R. May
Assistant Vice President
for Facilities and Operations
State University of New York
Binghamton, NY 13901

Dear Mr. May:

Effective September 1, 1985, Section 3002(b) of the Resource Conservation and Recovery Act (RCRA) requires all generators of hazardous waste, including this University, to make every effort to reduce that waste in both volume and toxicity before it can be offered to a company for disposal. A waste minimization certification is signed with each hazardous waste shipment affirming the above and also certifying that an economically practicable program is in place to accomplish this task.

As University hazardous waste manager, I am responsible for the day-to-day operation of the Hazardous Waste Management Program. This includes insuring compliance with all applicable local, state, and federal mandates. At this time, efforts to reduce the volume and toxicity of waste on this campus is practically non-existent. In order to comply with the recent RCRA waste minimization requirement, revision of the present program is prescribed.

Background

This brief historical perspective is based on Management Procedure Number 808 and available chemical waste disposal records. It should be understood that prior to RCRA (1980), hazardous waste, by legal definition, did not exist. Throughout this text, the term "chemical waste" will represent all chemical compounds that are unwanted by any person or group on this campus, including used oil and housekeeping supplies. The term "hazardous waste" identifies materials that meet the RCRA definition for hazardous waste and requires disposal by RCRA-approved methods.

Various methods of waste disposal were used prior to RCRA. The most common were through the county landfill and sanitary sewer system. Historically, this was the acceptable means of disposal by generators of chemical wastes. Due to the size of this University, actual quantities of chemicals disposed in this manner were small.

Waste motor oil was given to various local industries to be burned for energy recovery. This is still an acceptable method of disposal and is being used today.

During the 1970's environmental movement, changes in attitudes produced a shift in disposal methods. Efforts were made to reclaim solvent wastes by offering them to chemical companies marketing that service. A limited in-house recycling program was started that offered unopened or partially used bottles of chemicals to other persons in the department.

Chemicals that had no immediate value and posed a hazard were disposed by three basic methods. Unstable compounds were handled in-house, using procedures established by the Manufacturing Chemists Association. This process involved the ignition and subsequent incineration of the waste.

The second method was evaporation. Organic solvent wastes were transported to Cornell University where they were poured onto a Department of Environmental Conservation (DEC)-approved evaporation pad. This approval was later rescinded due to changes in the Clean Air Act standards.

The third method involved a process called "lab packing" and is still an approved U. S. Environmental Protection Agency (EPA) disposal method. "Lab packing" is a preparation whereby small containers of waste are placed in a larger metal container and surrounded with absorbent material for burial in a landfill. Existing disposal records indicate that 94 percent of all chemical wastes generated on this campus were disposed of in this manner since 1979. (The disposal of capacitors contaminated with polychlorinated biphenyls (PCB's) are not included in these estimates.)

PROPOSED REVISION

Although considered an ultimate disposal method, burying wastes, even in today's state-of-the-art secure landfills, is a long-term means of storage that requires constant safeguards against environmental contamination. This method does not eliminate the hazardousness of the waste. Furthermore, as the generator of buried hazardous wastes, this University would be responsible for a portion of any clean-up costs under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or "superfund").

Chemical wastes generated on this campus must not only be managed for their potentially hazardous nature, but also for their potential worth. Any chemical waste can be recycled and reused in some manner. The restrictions for accomplishing this are technology and cost. Nevertheless, a chemical waste management program should approach this goal using a combination of reuse and feasible disposal methods.

Chemical Waste Management Program

The program is systematically divided into three sections: generator, recycling, and disposal. Each section will follow standard operating procedures (SOP's) set forth by this Office. Responsibility for assuring that these procedures are carried out in a safe and responsible manner lies with the program manager (this author) and with the waste generators.

Generator Section

Individual laboratories and shops that generate chemical wastes must collect and store these wastes in a manner that minimizes risk to the health and safety of persons in the area. This responsibility not only lies with the teaching and research laboratories but also with painters, mechanics, machinists, photographers, printers/copiers, and custodians.

Some of the waste generated may be disposed safety and legally by the generator. Examples include non-hazardous waste such as sodium chloride, or certain photographic developer wastes that can be placed in hard trash (dumpster) or poured down the drain. Since the hazardousness of many wastes depends merely on quantity, disposal by the generator is discouraged unless approval is given by the program manager.

There are two basic waste streams produced on this campus. Liquid flammable wastes include gasoline, organic solvents, and other aqueous forms of organic chemical waste that are suitable for pouring and subsequent bulking for incineration. These liquid flammable wastes should be collected and stored in Factory Mutual Laboratories (FM)-approved safety containers that are specially designed with spring-loaded caps for pressure relief and spark arrestors that protect against accidental ignition. They are available in metal or polyethylene that hold quantities from 1 quart to 5 gallons. Since much of the liquid waste generated on campus contains water, the polyethylene cans are preferred. The metal containers have a tendency to rust out with time and leak their contents.

A log must be kept for each container. It should identify the container and its location. An entry should be made every time a liquid flammable waste is poured into it, indicating the date, the compound and quantity, and the disposer's initials. If only one compound (e.g., acetone) or a standard mixture (e.g., alcohol:xylene) is disposed, a single entry is acceptable. Mixture entries must also identify percentages (e.g.,alcohol: xylene 50:50). These logs should be single sheets of paper 5-1/2" by 8-1/2" in size with legible entries. Each log will stay with its container and become a permanent disposal record. This information is necessary to comply with state and federal disposal regulations.

Generators that produce small quantities of liquid flammable wastes occasionally or over a long period are not exempt from proper disposal. However, the waste manager should be contacted to make arrangements for special handling procedures. LIQUID FLAMMABLE WASTES SHOULD NEVER BE POURED DOWN THE DRAIN.

The second waste stream includes all other types of chemical wastes. Although by-products of experiments and research make up much of the waste, a number of items are unwanted chemicals in their original containers. Some of these "wastes" are new or unused chemicals that may be of value to other laboratory personnel on campus.

Wastes should be segregated into their compatible classes, i.e., acids, bases, flammables, poisons, and reactives. After making certain that the containers holding the chemicals (primary containers) are not broken, leaking, or otherwise unable to securely hold their contents, they should be placed into a sturdy box (secondary container) and surrounded with enough packing material to prevent breakage during transport. In most cases, the original bottles make the best primary containers.

Each box must be accompanied by a list containing generator information (name, telephone number, and location) and a line entry identifying the compound and quantity of each primary container. All containers must be clearly marked and identifiable. Unknowns cannot be accepted. It is the responsibility of the generator or department to identify the chemistry of the waste.

Unless prior arrangements have been made with the waste manager, delivery of waste chemicals will be made by the generator or other responsible party. Liquid flammable wastes in safety containers are collected in the Waste Chemical Shed (WCS) located behind the Science I building. All other wastes will be accepted at a location to be determined. The chemical waste manager must be contacted at extension 6834 to schedule a date and time for delivery.

Recycling Section

Upon receipt of the chemical wastes, a determination will be made regarding their fate. All liquid flammable wastes not suitable for in-house recycling will be poured into Department of Transportation (DOT)-approved 55-gallon drums. The appropriate documents will be maintained to identify drum contents for disposal purposes. Depending on the contents, ultimate disposal could be recycling, burning for heat recovery, or destruction by incineration.

All other chemical wastes will be further segregated into various categories based on their potential to be recycled or reduced in volume or toxicity. Below are brief descriptions of the waste categories that may be found on this campus and methods for their disposal.

Recyclables - Any chemical compound that does not break down or become contaminated with time will be offered for redistribution at no cost if they are in their original containers. A listing of materials will be made available to the science departments. If the chemical has not been redistributed after a period of time (e.g., 1 year), it will be disposed of through another category.

This cost-avoidance measure is a savings to the University in two ways. The user receives a needed compound without paying current prices and the cost to dispose of that compound is eliminated.

Lubricating Oils - Various oils are collected for heat recovery. Although maintenance is the collection point for used oil, this program will accept oil in quantities of less than five gallons. For the disposal of quantities of five gallons or more, arrangements should be made with the Maintenance Operations Center at extension 3932 during normal working hours.

Corrosives - The neutralization of many acids and bases can be accomplished in-house at little or no cost. For example, neutralization of inorganic acids forms mineral salts and water that can be safely disposed via the sanitary sewerage.

Reducers/Oxidizers - Many of these compounds are used in various processes to degrade other chemical wastes. Examples include the reduction of hexavalent chromium to the less toxic chromium +3 and the oxidation of cyanides with waste ammonium persulfate.

Poisons - Chemical compounds that are considered toxic (as defined by RCRA Extraction Procedure) will be considered hazardous waste and be disposed of in accordance with the procedures outlined in the disposal section below. Efforts will be made to reduce the volume of these wastes as safely and economically as practicable (e.g., dewatering, precipitation, filtering, etc.). Small quantities of these wastes may be processed and detoxified in-house.

Reactives - This category includes water-reactive, pyrophoric, and peroxide-forming compounds. Although some of these chemicals can be processed in-house, other extremely dangerous compounds should be disposed of by experienced off-site personnel.

Flammables - Some liquid flammable wastes may be recycled after a distillation process. This waste stream must be examined further to determine whether distillation is feasible for the amount generated on this campus. Until that time, these wastes will be bulked for incineration as described above.

Solid flammable wastes that cannot be solublized will be disposed as hazardous waste as discussed below.

Disposal Section

Any chemical waste that cannot be recycled or processed in-house will be declared a hazardous waste as defined by RCRA. The USEPA has authorized the State of New York to independently administer its hazardous waste management program. Therefore, the codes, rules, and regulations as defined by DEC will be followed.

After a waste is declared a hazardous waste, it shall be moved to the waste chemical shed (WCS) behind Science I for storage. All wastes will be segregated into compatible categories and clearly identified. A permanent log will be maintained, indicating stored wastes and accumulation start date.

The packaging of wastes will conform with RCRA, DOT, and disposal contractor requirements. Due to the detail of this information, it will not be discussed in this document.

Ultimate disposal methods will entail destruction of the waste, if possible. This will be accomplished by a reputable disposal company that has been approved and licensed by USEPA. Although incineration is desirable, other approved treatment methods will be accepted. Disposal via secure landfill will be avoided unless no other option is available within the program's capabilities.

Discussion/Program Requisites

This program will effectively reduce the amount of hazardous waste generated on this campus. Disposal costs will be reduced as a result. These efforts not only provide a monetary savings, they reduce liability by using environmentally sound disposal methods.

This reduction can be illustrated by examining the August 9, 1985 shipment of 37 drums of hazardous waste. The contents of each drum was identified and categorized according to the revisions proposed above. Using the minimization procedures and in-house recycling methods, the resultant waste volume would have been less than 10 drums. Furthermore, of these 10 drums all would be destroyed by incineration and/or hydrolysis, where 26 were land-filled and the contents of 3 (150 gallons) were deep-well injected. Based on a charge of $150.00/drum incinerated, the University would have saved over 70% in ultimate disposal costs.

In order to initiate this chemical waste management program, the following necessary items are requested:

Laboratory Space - A secure laboratory preferably located in the science complex. This laboratory should be of an adequate size and provide enough bench space to collect and process the wastes generated on this campus in a safe and efficient manner. Approximate floor space should be at least 175 sq.ft. with perimeter and island bench space.

Utilities must include hot and cold water, gas, a floor drain, at least one sink, and sufficient electrical outlets that permit access most anywhere in the lab. Steam and vacuum are desired but not required.

At least one chemical exhaust fume hood is necessary to control noxious and potentially hazardous airborne emissions from various degradation procedures. This hood should be operational with baffling and a working sliding sash. A drying oven below would aid in some reduction processes.

Laboratory Equipment - Most items are available through science stores, such as glassware, support stands, bottle carriers, etc. With time, the program will acquire other items from research and laboratory operations coming to a close.

Other items such as a 15-gallon nalgene vat for acid neutralization, motorized stirrer, and hot plate must be purchased off campus. Since most of these can be purchased under an existing contract, cost estimates at this time would be inflated and inaccurate. Some of these items may be available as material surplus through the appropriate departments in the science complex.

Although most materials will be one-time purchases, others will depend on use and demand (e.g., steel drums, degradation/neutralization chemicals, personal protective equipment, etc.). Given the fluctuation and uncertainty of chemical waste volumes, no estimates can be given. A more complete list of equipment and materials needed for the program can be found in Appendix A. This list is not all-inclusive. Some waste streams that are generated infrequently may require special handling and disposal apparatii.

Conclusions

In keeping with the University's tradition of excellence, a program such as this is paramount. The safe and efficient management of chemical waste is a national problem and global concern that demands immediate and constant attention. Expanding science-oriented course offerings, both graduate and undergraduate, and related research will continue to generate an increasing amount of waste requiring specialized handling and treatment. As this University expands its horizons, the management of chemicals must be included.

As manager of this program, I intend to confront management needs with foresight, using interdisciplinary methods. A program such as this must apply itself at all levels that may come into contact with chemical waste or chemicals that will become a waste. Education of those groups or individuals that use chemicals on campus becomes my most powerful tool. Education programs intended to fill a void presently on campus will increase the awareness of students, staff, and faculty of the program and its intent. Other subjects covered will include safety (safety in the laboratory, safe handling of chemicals, safe disposal methods), environmental protection, and the legal aspects of waste disposal.

The waste minimization ruling of RCRA requires immediate action. At this time, there are no means to accomplish such a task. Meanwhile, chemical wastes are continually being generated. I respectfully request you give this your utmost consideration. It is my belief that the University Center at Binghamton will become a leader in the field of chemical waste management and the proposed program can be used as a model for the other State University of New York units.

Sincerely,

David M. Coons

David M. Coons
Campus Technical Specialist

DMC:jcs

xc: J. Warren Corderman
Robert Melville

LIST OF PHYSICAL SPACE AND EQUIPMENT NEEDS

Laboratory Space

Location : Science Complex.

Size : A minimum of 175 square feet.

Utilities : Typical laboratory-oriented facilities. Other non-essential but preferable utilities are steam and vacuum. Plumbing must include floor drainage. An oversized sink is desired but not required.

Ventilation: Negative static pressure providing at least 12 air changes per hour. Exhaust should be a dedicated non-recirculating system.

Other : Personal Protective Equipment - Operational walk-in fume hood complete with baffling, sliding sash, and appropriate utilities.

Combination hand-held emergency shower/eye wash.

FM-approved flammable liquid storage cabinet (45-gallon capacity).

Adequate shelving and benchtop space to accomodate short-term collection and manipulation of materials.

Equipment Needs - Recycling

Safety Cans: 9 each, U.L. listed, FM approved. Non-metal with spring-loaded lid and spark arrestor.

Mixing Tank: 1 each, Nalgene, 15-gallon capacity with spigot.

Lab Stirrer: 1 each, Eastern model 5VB or equivalent, 1700 rpm maximum with 12-inch shaft and 3-inch propeller.

Stirrer-Heater: 1 each, Nuova II or equivalent, plate area 49 sq. in., stirring speed 60 to 1000 rpm. Includes 1 (one) TFE-coated stirring bar.

Hygrometer : Specific gravity/Baume, Universal.

pH/mV Meter: 1 each, Accumet 800 analog, or equivalent.
Temperature compensation 0°-100° C.
Range: 0-14 pH/0 to ±700 mV. Flexible electrode support arm, combination electrode, dust cover.

Balance: Ohaus, triple-beam, model 760.
Corrosion-resistant, 15 cm. flat plate, self-aligning bearings, 225 gram tare beam.

Glassware : Separatory funnel, 500 ml.

Round-bottomed flask, 3-neck, 500 ml.

Reflex condenser

Filtering flasks, 500, 1000 ml.

Buchner funnel

Graduated cylinder, 100 ml.

Assorted beakers and Erlenmeyer flasks

Various glassware-related materials (e.g., connectors, stops, tubing, grease)

Supplies : Bunsen burner
Carrier for acid bottles
Carrier for solvent bottles
Utility and tubing clamps
Support stand with rods
Pan, 10-quart
Filter paper

Personal Protection: Nalgene, curved shield (30"x16" W.)
Gloves, Nitrile, 13", size 10
Chemical splash goggles, Encon
Coveralls, machine washable
Fire extinguisher, Class ABC
Fire extinguisher, Class D
First aid kit.

Equipment Needs - Disposal

Safety Fill Vent and Funnel: Brass vent with automatic pressure and vacuum relief. Polyethylene funnel. FM-approved.

Safety Drum Truck: Four-wheeled hand truck for transporting 30- and 55-gallon drums of waste weighing in excess of 800 pounds.

Drum Repair Kit: Emergency repair kit for leaking drums of hazardous waste. Materials include various patching supplies and tools.

Emergency Eyewash/Shower: Portable or permanent for the waste chemical shed located behind Science I.

DOT-Approved Drums: Various sizes as needed for transporting hazardous waste off campus.

Miscellaneous: Paints, markers, forms, placards, as needed.

References

The Merck Index, 10th edition. Rahway, New Jersey: Merck and Company, Inc., 1983.

Chemical Technician's Ready Reference Handbook, 2nd edition. Shugar/Baumann. New York, New York: McGraw Hill, 1981.

CRC Handbook of Chemistry and Physics. Robert C. Weast. West Palm Beach, Florida: CRC Press, Inc., 1984.

Clinical Toxicology of Commercial Products, 5th edition. Gosselin, Smith, and Hodge. Baltimore, Maryland: Williams and Wilkins, 1982.

Patty's Industrial Hygiene and Toxicology, volume 2, parts A, B, and C. New York, New York: John Wiley and Sons, Inc., 1980, 1981, 1982.

UNIVERSITY CENTER AT BINGHAMTON
Assistant Vice President for Facilities and Operations

DATE: December 10, 1985

TO: Mr. Melville

FROM: Mr. May

SUBJECT: Waste Management Program

You have a copy, Bob, of Mike Coons' comprehensive letter to me dated November 27 concerning this university's waste management program.

The bottom line of this persuasive analysis is that a modest amount of space in Science II, preferably Chemistry, and approximately $4,000 of equipment funds will allow Mike to significantly refine the university's Waste Management Program and measurably reduce this university's costs of hazardous waste disposal.

Would the Arts and Sciences Dean's Office allocate up to $4,000 to purchase the equipment and supplies described in the letter, and could Mr. Coons be assigned a minimum of 175 square feet of laboratory space in the Science Complex to work on this program?

Mike, Warren, and I would be pleased to meet with you and others, or to provide any additional information you wish.

Walt
Walter R. May
Assistant Vice President
for Facilities and Operations

WRM:bg

cc: Mr. Corderman
Mr. Coons ✓

University Center at
Binghamton

State University of New York / Binghamton, New York 13901

Associate Dean of Arts and Sciences
and of Harpur College
Telephone (607) 777-4941

MEMORANDUM

DATE: December 24, 1985

TO: David M. Coons, Campus Technical Specialist
J. Warren Corderman, Safety Coordinator

FROM: Robert F. Melville Robert F. Melville
Associate Dean of Arts and Sciences

SUBJECT: Hazardous Waste Management

In discussing with Bruce Norcross the proposal from Mike, Bruce expressed two concerns that I want to pass on. They are very positive about the program but note that the procedure depends in part on the accuracy of labels. You will combine organics based on the labels. Some people may, unfortunately, fill out the labels to meet the system, not to be accurate. When two things, one or both mislabeled, are combined in quantity, there could be a disaster which may cause serious injury, perhaps to Mike. There needs to be procedural safeguards which protect against error, such as some initial testing of small quantities. I would strongly urge that you consult closely with appropriate people in Chemistry to get the best possible technical advice.

The second point has to do with handling of "unknowns." On page four of the proposal it is stated that "unknowns cannot be accepted." We understand the problem, but I don't think we can leave it at that for two very good reasons. If an "unknown" is discovered it will end up somewhere. The worst place from a standpoint of safety may be the lab where it was found. It may be that it is not possible for the generator to identify its chemistry. For one thing that person may be long gone from here and possibly deceased. A person may still be here but not be able to remember and there may be no way to determine it. Finally, this is a research university and no one may know the chemistry of some new compound.

Note that if we say you are stuck with any "unknown" the temptation is to make it officially a "known" by guessing at the chemistry for labeling purposes or, more simply, by intentional mislabeling. My point is that our failure to deal with "unknowns" invites some potentially dangerous behavior. I don't have the answer, but it is clear to me that it is not to ignore the problem. We will inevitably turn up "unknowns" from time to time, and we must face up to that fact and agree on what to do with them.

RFM:lso

APPENDIX C

REPRESENTATIVE LOG SHEETS FOR THE BULKED DRUMS OF SOLVENT WASTE

DRUM 121185 #38N

MIXED NON-HALOGENATED

DATE 1985		LOCATION / COMPOUND	1 ALCOHOL	2 ALIPHATIC	3 AROMATIC	4 ETHER/ESTER (E) (S)	5 KETONE/ALDEH. (K) (A)	6 MISC. W-WATER
11	7	302 FA						
		Turpentine		38000				
12	11	314 S2						
		Hexane		13400				
		Diethyl Ether				11200 E		
		Ethyl Acetate				4200 S		
		Acetone					7000 K	
		Methanol	2400					
		Ethanol	1200					
		2-Propanol	400					
		Ferrous Sulfate						<1
12	11	UNK S2						
		Benzene			95			
		Toluene			95			
		Ethyl Acetate				757 S		
12	11	302 S2						
		Acetone					6000 K	
		Benzene			3600			
		Hexane		4800				
		Toluene			4800			
		Ethyl Acetate				4800 S		
12	11	307 S2						
		Ethanol	28500					
		KOH						760
		Water						6840 W
		Benzene			380			
		Toluene			380			
		Thiophenol			380			
		Piperidine						380
12	11	214 S2						
		Ethyl Acetate				3800 S		
		Methanol	2375					
		Water						125 W
		p-Nitroaniline						<1
12	11	805 S2						
		Hexane		10800				
		Benzene			10800			
		Acetone					10800 K	
		DMSO						[illegible]
		Acetonitrile						[illegible]
		Methanol	3000					

DRUM 121185 #38N
cont.

	DATE 1985	LOCATION COMPOUND	1 ALCOHOL	2 ALIPHATIC	3 AROMATIC	4 ETHER/ESTER (E) (S)	5 KETONE/ALDEH. (K) (A)	6 MISC. W-WATER
1	12 11	805 S2 (cont.)						
2		Pet Ether		2400				
3	12 11	270 S3						
4		Pet Ether		345				
5		Hexane		233				
6		Diethyl Ether				158E		
7		Glacial Acetic Acid						15
8	12 11	B11 S4						
9		Paint Thinner		3800				
10	12 11	156 S4						
11		Ethanol	2280					
12		Propanol	1900					
13		Xylene			18620			
14								
15		Subtotals	42055	73778	39150	11358E	23800K	2357
16						13557S		6965W
17								
18		Total	213020ml	≈56Gl				

22 606

DRUM 010786 #01 N
MIXED NON-HALOGENATED

DATE 1986		LOCATION / COMPOUND	1 ALCOHOL	2 ALIPHATIC	3 AROMATIC	4 ETHER/ESTER (E) (S)	5 KETONE/ALDEH. (K) (A)	6 MISC. W-WATER
1	7	214 S2						
		Hexane		1200				
		Ethyl Acetate				2800 S		
1	7	617 S3						
		Aq DAB						500
		Xylene			12000			
1	7	156 S4						
		Butanol	4000					
		Xylene			6048			
		Ethanol	756					
		Propanol	756					
2	4	302 S2						
		Acetone					3000 K	
		Benzene			1800			
		Toluene			2400			
		Hexane		2400				
		Ethyl Acetate				2400 S		
2	4	205 S2						
		Acetone					17700 K	
		Benzene			14700			
		DMSO						200
		Methanol	1000					
		Ethanol	600					
		Cyclohexane		200				
		DMF						2800
		Ethyl Acetate				200 S		
		Acetonitrile						400
		Nitromethane						200
		Methyl Benzoate						200
		Piperidine						200
		THF				1200 E		
		Diethyl Ether				1400 E		
		Tetrahydronaphthalene			400			
		t-Butanol	800					
		Hexane		13000				
		Ferric Sulfate						<1
2	4	B2 S2						
		Ethanol	21735					
		Ethylene Glycol	4834					
		Water						3571 W
		Aq [illegible] Dye						150

DRUM 010786 HOIN
CONT.

DATE 1986	LOCATION / COMPOUND	1 ALCOHOL	2 ALIPHATIC	3 AROMATIC	4 ETHER/ESTER (E) (S)	5 KETONE/ALDEH. (K) (A)	6 MISC. W-WATER
3 7	302 FA						
	Turpentine		37860				
3 7	268 S1						
	2-Propanol	500					
3 7	302 S2						
	Acetone					2787 K	
	Benzene			1400			
	Toluene			1400			
	Ethyl Acetate				1600 S		
	Hexane		1600				
	Thiourea						312
	Water						150 W
3 7	314 S2						
	Methanol	2400					
	Acetone					7200 K	
	Hexane		13600				
	Ethyl Acetate				7400 S		
	Diethyl Ether				7600 E		
	Toluene			6800			
	Benzene			1200			
	Water						800 W
	Ferric Sulfate						<1
3 7	156 S4						
	Acetone					4969 K	
	Glacial Acetic Acid						1656
	Subtotals	37381	70660	48148	10200 E 15400 S	35656 K	6620 4541 W
	Total	228606 ml	≈ 60 gl.				

APPENDIX D

REPRESENTATIVE CHEMICAL WASTE DOCUMENTS

PAGE 1 of 1

CHEMICAL WASTE DOCUMENT
UNIVERSITY CENTER AT BINGHAMTON
DIVISION OF OCCUPATIONAL SAFETY AND HEALTH

DATE 3-7-86 ROOM/BUILDING 156 S4 PHONE NO. X2578

RESPONSIBLE PARTY Obeda Lavin SIGNATURE Obede H. Lavin

(Classes: Acid; Base; Flammable; Poison; Oxidizer; Reducer; Reactive)

FATE	COMPOUND NAME	QUANTITY	CLASS
#C1 ✓	Glacial Acetic Acid : Acetone 1:4	3/4 gal	
#C5 ✓	Xylene : Abs EtOH : Propanol 80:10:10	1 gal	
#C3 ✓	Butanol	3/4 gal	
#C1 ✓	Glacial Acetic : Acetone 1:4	1 gal	

CHEMICAL WASTE CERTIFICATION: The above signed hereby certifies that the information on this document is accurate and that all chemical waste containers are labelled to identify their contents. Contact the Chemical Waste Manager at x2211 if there are any questions. Thank you.

CWD 2-86

PAGE 1 of 1

CHEMICAL WASTE DOCUMENT
UNIVERSITY CENTER AT BINGHAMTON
DIVISION OF OCCUPATIONAL SAFETY AND HEALTH

ATE 4-25-86 ROOM/BUILDING Sign Shop PHONE NO. 2292

RESPONSIBLE PARTY Karen Comfort SIGNATURE Karen M.

(Classes: Acid; Base; Flammable; Poison; Oxidizer; Reducer; Reactive)

FATE	COMPOUND NAME	QUANTITY	CLASS
6.5 Neutralized	Ammonium Hydroxide	10oz	
4-25 #03	Gasoline	100ml	

CHEMICAL WASTE CERTIFICATION: The above signed hereby certifies that the information on this document is accurate and that all chemical waste containers are labelled to identify their contents. Contact the Chemical Waste Manager at x2211 if there are any questions. Thank you.

CWD 2-86

PAGE 1 of 1

CHEMICAL WASTE DOCUMENT
UNIVERSITY CENTER AT BINGHAMTON
DIVISION OF OCCUPATIONAL SAFETY AND HEALTH

DATE 8-29-86 ROOM/BUILDING P164 Eng PHONE NO. 2715

RESPONSIBLE PARTY Robert Kaub SIGNATURE R. J. Kaub

(Classes: Acid; Base; Flammable; Poison; Oxidizer; Reducer; Reactive)

FATE	COMPOUND NAME	QUANTITY	CLASS
c) ELT Rcd 3.3.97	Ammonium persulfate : H_2O	5 gal	
	216 : 1 gal		

CHEMICAL WASTE CERTIFICATION: The above signed hereby certifies that the information on this document is accurate and that all chemical waste containers are labelled to identify their contents. Contact the Chemical Waste Manager at x2211 if there are any questions. Thank you.

CWD 2-86

PAGE 1 of 1

CHEMICAL WASTE DOCUMENT
UNIVERSITY CENTER AT BINGHAMTON
DIVISION OF OCCUPATIONAL SAFETY AND HEALTH

ATE 9·11·86 ROOM/BUILDING 307 S2 PHONE NO. 6506

RESPONSIBLE PARTY Steven Seysmith SIGNATURE

(Classes: Acid; Base; Flammable; Poison; Oxidizer; Reducer; Reactive)

FATE	COMPOUND NAME	QUANTITY	CLASS
NEUT DILT 2·21·87	Ethanolic KOH	5gal	
—			
—			

CHEMICAL WASTE CERTIFICATION: The above signed hereby certifies that the information on this document is accurate and that all chemical waste containers are labelled to identify their contents. Contact the Chemical Waste Manager at x2211 if there are any questions. Thank you.

CWD 2-86

APPENDIX E

MATERIAL WASTE PROFILE SHEETS
GSX SERVICES, INC.

MATERIAL PROFILE SHEET

GSX

STATE UNIVERSITY OF NEW YORK

. 10% FORMALIN WASTE

Facility Name University Center at Binghamton
EPA Identification Number: NYD071600100
Address Vestal Parkway East
Contact Name: David M. Coons
City Binghamton State NY Zip 13901
Title: Environmental Hygienist Phone: (607) 777-2211
Process Generating Waste Biology Sample Preservation
Frequency ~100 gallons/year
Physical State at 70°F Solid ☐ Semisolid ☐ Liquid ☒ Appearance Clear-Golden
Layers at 70°F None ☒ Two ☐ Multilayers ☐
Waste Flash Point Exact Flash Point ______ °F. or Ranges < 60°F ☐. 61°F-100°F ☐. 101°F-140°F ☐. 141°F-199°F ☐. > 200°F ☒
Waste Viscosity Low ☒ Medium ☐ High ☐ Specific Weight (lb/gal) ~8 # Precipitated Solids <5 %
Waste pH 6-8 BTU (lb.) 0 # ASH (%) <5 % H_2O (%) 90 + % T.O.H. (%) 0 %
Free Cyanide 0 ppm Free Sulfide 0 ppm PCB's 0 ppm Dioxin 0 ppm Radioactive Yes ☐ No ☒
Reactivity: Reactive With oxidizers Reactivity Products: Gas ☒ Heat ☐ Flame ☐ Polymerization ☐

CHEMICAL CONSTITUENTS 37% Formaldehyde = 10 %

TOTAL METALS (PPM)

As	<1	Ag	<1	Cd	<1	Ba	<1	Cr	<1	Pb	<1	Hg	<1	Se	<1
Co	<1	Na	<1	Mg	<1	Ti	<1	Mn	<1	Sb	<1	Ni	<1	Zn	<1
Cu	<1	Si	<1	Fe	<1	Cr+3	<1	Cr+6	<1						

Other Information:
Waste Container Type Drum ☒ Bulk ☐ Other ______ EPA Waste Code U122 State Waste Code U122

David M. Coons June 12, 1986

NAME David M. Coons
TITLE Environmental Hygienist
DATE June 12, 1986

MATERIAL PROFILE SHEET

GSX

STATE UNIVERSITY OF NEW YORK

WASTE TOLUENE

Facility Name University Center at Binghamton

EPA Identification Number: NYD071600100

Address Vestal Parkway East

Contact Name: David M. Coons

City Binghamton **State** NY **Zip** 13901

Title: Environmental Hygienist **Phone:** (607) 777-2211

Process Generating Waste Paint Shop

Frequency 100-200 gallons/year

Physical State at 70°F Solid ☐ Semisolid ☐ Liquid ☒ **Appearance** yellow white **Layers at 70°F** None ☒ Two ☐ Multilayers ☐

Waste Flash Point Exact Flash Point ____ °F. or Ranges < 60°F ☒. 61°F-100°F ☐. 101°F-140°F ☐. 141°F-199°F ☐. > 200°F ☐

Waste Viscosity Low ☒ Medium ☐ High ☐ **Specific Weight** (lb/gal) 7-8 # **Precipitated Solids** < 5 %

Waste pH 5-9 **BTU** (lb.) ~18,000 # **ASH** (%) < 5 % **H_2O** (%) 0 % **T.O.H.** (%) 0 %

Free Cyanide 0 ppm **Free Sulfide** 0 ppm **PCB's** 0 ppm **Dioxin** 0 ppm **Radioactive** Yes ☐ No ☒

Reactivity: Reactive With oxidizers **Reactivity Products:** Gas ☐ Heat ☐ Flame ☒ Polymerization ☐

CHEMICAL CONSTITUENTS Toluene = 100 %

TOTAL METALS (PPM)

As <1 Ag <1 Cd <1 Ba <1 Cr <1 Pb < 1 Hg <1 Se <1

Co <1 Na <1 Mg <1 Ti <1 Mn <1 Sb < 1 Ni <1 Zn <1

Cu <1 Si <1 Fe <1 Cr + 3 <1 Cr + 6 <1

Other information:

Waste Container Type Drum ☒ Bulk ☐ Other ____ **EPA Waste Code** U220 **State Waste Code** U220

David M. Coons June 12, 1986

NAME David M. Coons

TITLE Environmental Hygienist

DATE June 12, 1986

MATERIAL PROFILE SHEET

GSX

STATE UNIVERSITY OF NEW YORK

HALOGENATED SOLVENT WASTE

Facility Name University Center at Binghamton

EPA Identification Number: NYD071600100

Address Vestal Parkway East

Contact Name: David M. Coons

City Binghamton **State** NY **Zip** 13901

Title: Environmental Hygienist **Phone:** (607) 777-2211

Process Generating Waste Research and Academic Laboratories

Frequency ~2 x 55gallon drums/6 months

Physical State at 70°F Solid ☐ Semisolid ☐ Liquid ☒ **Appearance** Amber-Red **Layers at 70°F** None ☐ Two ☒ Multilayers ☐

Waste Flash Point Exact Flash Point ______ °F. or Ranges < 60°F ☐. 61°F-100°F ☒. 101°F-140°F ☐. 141°F-199°F ☐. > 200°F ☐

Waste Viscosity Low ☒ Medium ☐ High ☐ **Specific Weight** (lb/gal) 7-8 # **Precipitated Solids** 0-5 %

Waste pH 5-9 **BTU** (lb.) ~10,000 # **ASH** (%) <5 % **H_2O** (%) 0-3 % **T.O.H.** (%) (Cl) 25-40 %

Free Cyanide <1 ppm **Free Sulfide** <1 ppm **PCB's** 0 ppm **Dioxin** 0 ppm **Radioactive** Yes ☐ No ☒

Reactivity: Reactive With oxidizers **Reactivity Products:** Gas ☐ Heat ☐ Flame ☒ Polymerization ☐

CHEMICAL CONSTITUENTS

C_1-C_6 Alcohols = 3-10 %
Aliphatics = 10-60 %
Aromatics = 5-25 %
Ethers = 2-15 %
Esters = 5-20 %
Ketones = 5-20 %
Aldehydes = 0-5 %
Turpentine = 0-5 %
Amines = 0-5 %
Miscellaneous = 0-3 %
______ = ____ %

TOTAL METALS (PPM)

As	<1	Ag	<1	Cd	<1	Ba	<1	Cr	<1	Pb	<1	Hg	<1	Se	<1
Co	<1	Na	<1	Mg	0-1	Ti	<1	Mn	0-1	Sb	<1	Ni	0-1	Zn	<1
Cu	<1	Si	<1	Fe	0-3	Cr+3	<1	Cr+6	<1	Mo	0-1	W	0-1		

Other Information: Misc. may contain amides, sulfides, dyes, and neutralized mineral acids and bases.

Waste Container Type Drum ☒ Bulk ☐ Other ______ **EPA Waste Code** D001 **State Waste Code** D001

[illegible]

David M. Coons June 12, 1986

NAME David M. Coons
TITLE Environmental Hygienist
DATE June 12, 1986

MATERIAL PROFILE SHEET

GSX

STATE UNIVERSITY OF NEW YORK

NON-HALOGENATED SOLVENT WASTE

Facility Name University Center at Binghamton
EPA Identification Number: NYD071600100
Address Vestal Parkway East
Contact Name: David M. Coons
City Binghamton **State** NY **Zip** 13901
Title: Environmental Hygienist **Phone:** (607) 777-2211
Process Generating Waste Research and Academic Laboratories
Frequency ~4 x 55 gallon drums/6 months
Physical State at 70°F Solid ☐ Semisolid ☐ Liquid ☒ **Appearance** Amber-Red **Layers at 70°F** None ☐ Two ☒ Multilayers ☐
Waste Flash Point Exact Flash Point ______ °F, or Ranges < 60°F ☐, 61°F-100°F ☒, 101°F-140°F ☐, 141°F-199°F ☐, > 200°F ☐
Waste Viscosity Low ☒ Medium ☐ High ☐ **Specific Weight** (lb/gal) 7-8 # **Precipitated Solids** 0-5 %
Waste pH 5-9 **BTU** (lb.) ~18,000 # **ASH** (%) <5 % **H_2O** (%) 0-3 % **T.O.H.** (%) 0 %
Free Cyanide <1 ppm **Free Sulfide** <1 ppm **PCB's** 0 ppm **Dioxin** 0 ppm **Radioactive** Yes ☐ No ☒
Reactivity: Reactive With oxidizers **Reactivity Products:** Gas ☐ Heat ☐ Flame ☒ Polymerization ☐

CHEMICAL CONSTITUENTS
C_1-C_6 Alcohols = 5-30 %
Aliphatics = 10-25 %
Aromatics = 15-25 %
Ethers = 5-15 %
Esters = 5-15 %
Ketones = 5-20 %
Aldehydes = 0-5 %
Turpentine = 10-20 %
Amines = 0-7 %
Miscellaneous = 1-3 %
______ = ______ %

TOTAL METALS (PPM)

As	<1	Ag	<1	Cd	<1	Ba	<1	Cr	<1	Pb	<1	Hg	<1	Se	<1
Cu	<1	Na	<1	Mg	0-1	Ti	<1	Mn	0-1	Sb	<1	Ni	0-1	Zn	<1
Cu	<1	Si	<1	Fe	0-5	Cr + 3	<1	Cr + 6	<1	Mo	0-1	W	0-1		

Other Information: Misc. may contain Amides, sulfides, dyes, and neutralized mineral acids and bases
Waste Container Type Drum ☒ Bulk ☐ Other ______ **EPA Waste Code** D001 **State Waste Code** D001

David M. Coons June 12, 1986

NAME David M. Coons
TITLE Environmental Hygienist
DATE June 12, 1986

END

U.S. DEPT. OF EDUCATION

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